.2 E.G. Guerin / EB14

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DEVELOPMENT OF ROBOTICS FACILITY DOCKING TEST HARDWARE

Contract NAS8-34656

(NASA-CR-171153) DEVELOPMENT OF ROBOTICS FACILITY DOCKING TEST HARDWARE Final Report (Essex Corp.) 106 p HC A06/MF A01 CSCL 14B

N84-33433

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August 31, 1984

Essex Report Number H-84-05

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FOREWORD

This final report represents the results of a 12-month effort by Essex Corporation to design and fabricate test hardware for NASA's George C. Marshall Space Flight Center (MSFC) under contract NAS8-34656. A docking device conceptually developed by Essex for MSFC under contract NAS8-33073 was fabricated. Also, two docking targets providing high and low mass docking loads were required and were represented by an aft 61.0 cm section of a Hubble Space Telescope (ST) mockup and an upgrading of an existing Multimission Modular Spacecraft (MMS) mockup respectively. In addition, a test plan was developed for testing the above-mentioned hardware.

The support and guidance provided by Ed Guerin (EB14), the contract COR, and Richard Cloyd (EP36) were especially helpful in the performance of the hardware design, and the assistance of Frank Vinz (EB44) in interfacing with the 6 DOF equipment in MSFC's Building 4663 was both timely and appreciated.

The assistance of John Haslam, David Henderson, Keith Savas, and Nicholas Shields in fabricating and integrating the mockups in the Teleoperator and Robotics Evaluation Facility is gratefully acknowledged. Appreciation is also extended for their preparation of the Test Requirements section of this report.

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1.0 INTRODUCTION

1.1 BACKGROUND

Prior to the successful retrieval, repair, and release of the Solar Maximum Mission (SMM) satellite during Shuttle Mission 41-C, all spacecraft docking has been performed on a manual vehicular level with one or more onboard crew members piloting the chase vehicle and operating the docking hardware. The use of the Remote Manipulator System (RMS) for retrieval of the SMM demonstrated the feasibility of remote docking. This technique had certain elements in common with both the manned chase vehicle/target capture and totally remote docking systems in that the Orbiter had to be positioned within capture distance of the target satellite and the crewmember was required to remotely "pilot" the end effector of the RMS into a capture position in order to secure the target.

These docking techniques have proven feasible in prior missions and will, in all probability, continue to be used in the future when appropriate. However, there are situations in which neither method of docking will suffice. These include: 1) the capture of a satellite which is beyond the operating range of the Orbiter/RMS reach envelope, 2) the capture of satellites which may be sensitive to concentrations of contaminants found near an actively maneuvering Orbiter, and 3) satellites which may present a hazard to the Orbiter or crew through malfunction or design. Thus, the development of truly remote docking hardware and techniques will allow a wide range of docking scenarios to be enacted.

The development of prototypical docking hardware, as well as realistic docking targets (i.e., ST and MMS) which have well defined berthing pins, was therefore necessary to expand the development of remote crew station configurations, training procedures, lighting and video constraints and parameters which has been an on-going activity at MSFC since 1972.

The Teleoperator and Robotics Evaluation Facility (TOREF, MSFC Bldg. 4619), and the six degree of freedom (6DOF) simulator (MSFC Bldg. 4663) provide facilities for a wide range of evaluation and development techniques concerning remote docking.

1.2 SCOPE

The purposes of this contract were to: 1) provide a full-size mockup of the ST aft end to represent a large, massive docking target, 2) upgrade the existing MMS to represent a smaller, less massive docking target, 3) fabricate the three-element docking device designed under a previous Essex/MSFC contract to mate with both spacecraft docking targets, and 4) identify the docking test requirements.

2.0 TASK DESCRIPTIONS

Four contract tasks were performed as described below.

2.1 TASK 1 - DEVELOPMENT OF SPACE TELESCOPE MOCKUP

A full size mockup of the ST aft end (Figure 2.1 and Appendix A) was constructed using drawings obtained from Lockheed Missile and Space Company as well as Interface Control Documents (ICDs) obtained from MSFC engineering personnel. The ICDs were used in the design of the three berthing pins as no machine drawings were available.

The frame of the main cylinder of the ST mockup was constructed primarily of 3.2 mm thick aluminum architectural angle formed and welded into three wedge-shaped sections 61.0 cm thick (see Appendix A). Internal bracing provided a rigid, lightweight structure (< 100 kg) on which the berthing pins, vents, connector tower, docking target, and handrails were mounted. Mounting to the gimbal system for roll, pitch, and yaw was accomplished through the use of a central support tube which also added rigidity and served as an attach point for the diagonal and radial support members. All external surfaces of the mockup were covered with corrugated fiberboard, which served as a base for attachment of the simulated insulation blanket as well as a mounting surface for some of the lighter visual features. The corrugated fiberboard was attached to the frame with large head pop rivets.

The insulation blanket which covers the ST was simulated by 6.4 mm thick bubble-type plastic packaging material covered with .05 mm adhesive-backed metalized mylar film. The result was a bright silver specular finish which closely approximated samples of the actual insulation blanket obtained from MSFC engineering personnel.

The berthing pins (Dwg. No. 47ɩ'01, Appendix A) were constructed of stainless steel pipe which was machined on the outside surface to provide the proper 3.81 cm outside diameter and resulted in a wall thickness of 4.6 mm. The supporting brackets were machined from single billets of 6061-T6 aluminum alloy.

A review of design requirements for mounting the berthing pins above the 6 DOF simulator revealed the desirability of constructing an additional structure for this purpose rather than utilizing a dual purpose berthing pin mount as originally proposed. The benefits gained from this approach included: 1) more structural integrity of the flat floor ST mockup, and 2) ease of transfer of the ST mockup from one facility to the other without disassembly. This structure was fabricated at no additional expense to MSFC.

The support stand for the ST mockup underwent several design modifications due to changes in its location on the perimeter of the epoxy flat floor. Early in the design phase it was decided that the

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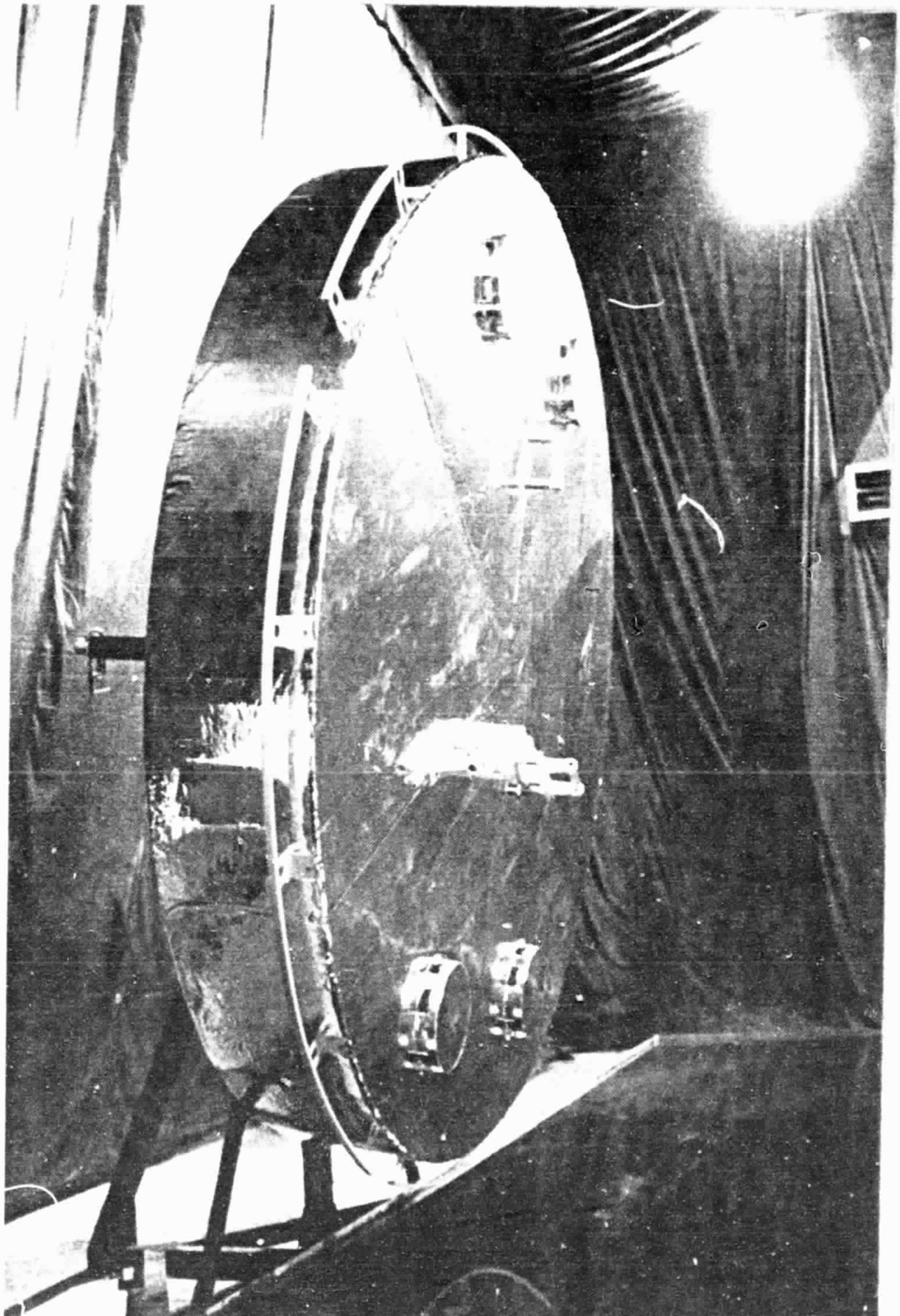

Figure 2.1: SI Mockup Installed on Perimeter of Air Bearing Flat Floor

addition of yaw in the support structure was advisable in order to compensate for torsional stresses anticipated during testing with the Teleoperator Motion Base (TOM-B). Likewise, a bearing system was provided to allow the mockup to be lifted vertically (Z axis) as much as 45.7 cm. This feature was provided as a precaution to avoid damage in the event that a + Z command was given the TOM-B after docking had been accomplished.

The stand was mounted to the concrete floor adjacent to the epoxy floor using 3/8-inch lead anchors. Additional tie downs were provided at the rear of the base to assure that the structure did not tip over.

2.2 TASK 2 - MODIFICATION AND INSTALLATION OF MMS MOCKUP

The original contract required the upgrading of the existing wood and foam core mockup of the aft end of the MMS. An on-site inspection of this structure revealed that the mockup had sustained considerable damage over the years due to testing and frequent moves. The decision was therefore made by Essex to build a new mockup at no additional expense to MSFC.

The new mockup was constructed (Figure 2.2 and Appendix B) of a light-weight aluminum frame covered with the same materials used on the ST mockup, resulting in a realistic approximation of the flight laminated insulation blanket. New berthing pins were constructed using drawings of flight equipment as a guide. As a weight-saving measure, these devices were made of aluminum instead of stainless steel. One additional change from the old mockup was to make the new one 30.5 cm long, instead of 61.0 cm, to reduce loading of the Target Motion Simulator mounting base.

2.3 TASK 3 - FABRICATION AND INSTALLATION OF DOCKING DEVICE

2.3.1 Development of Docking Device Design

The original design specified under MSFC contract NAS8-33073 utilized a passive latch/active unlatch design driven by a pair of rotary solenoids. While the design was feasible, it was not deemed optimal and lacked several highly desirable characteristics, including active latching and a method of determining whether or not a target pin was indeed captured. During the initial design phase, a concept was developed which utilized sliding passive latches and motor-driven cams which were of such a geometry as to grasp and retract the berthing pin if it fell within the capture range (Figure 2.3). Back driving of the latch mechanism was avoided through the use of a worm-wheel drive train.

An informal Preliminary Design Review (PDR) was conducted on October 4, 1983 with Frank Vinz, Gobe Vic, Ed Guerin, and Essex

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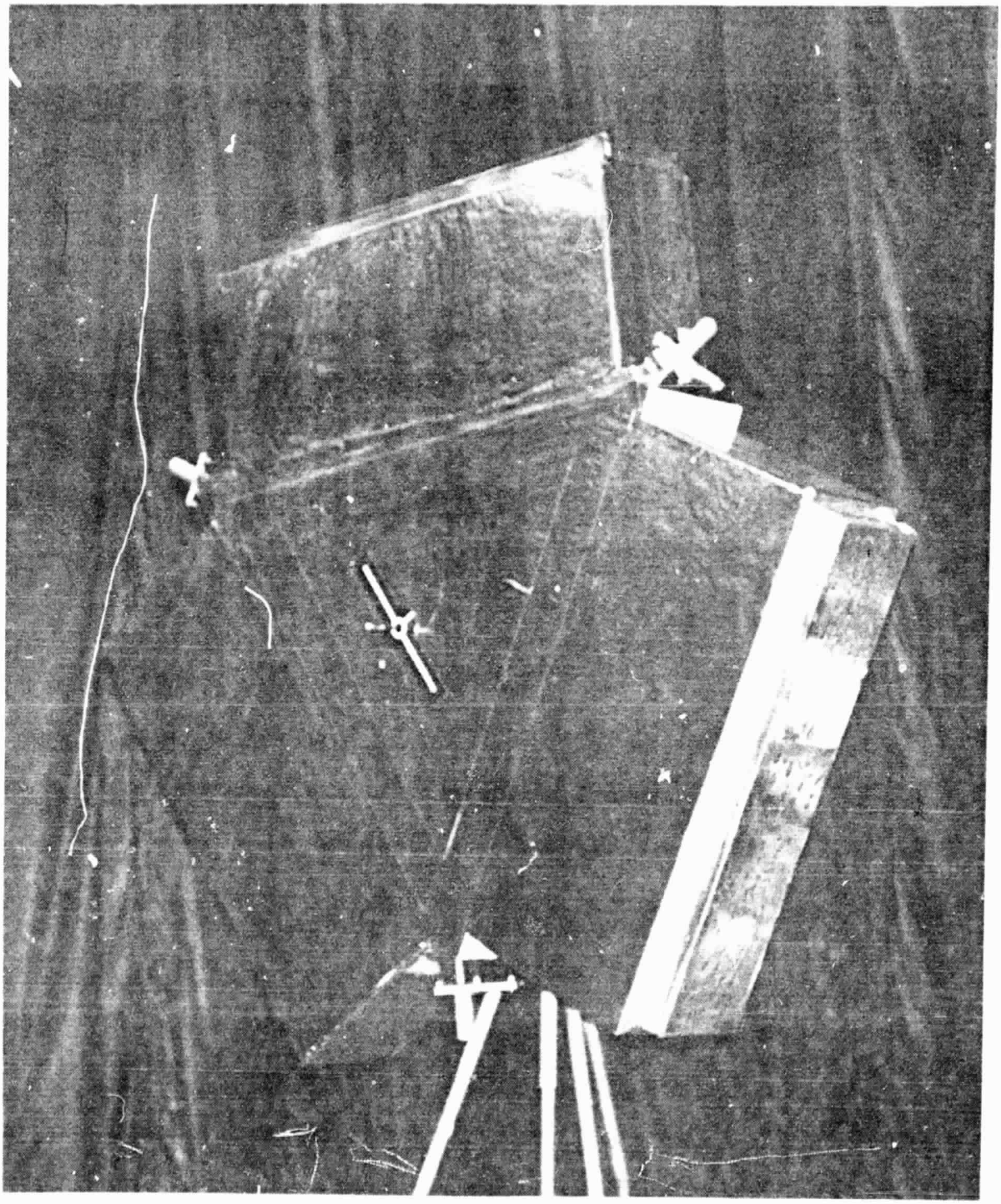

Figure 2.2: MMS Mockup Installed on Target Motion Simulator

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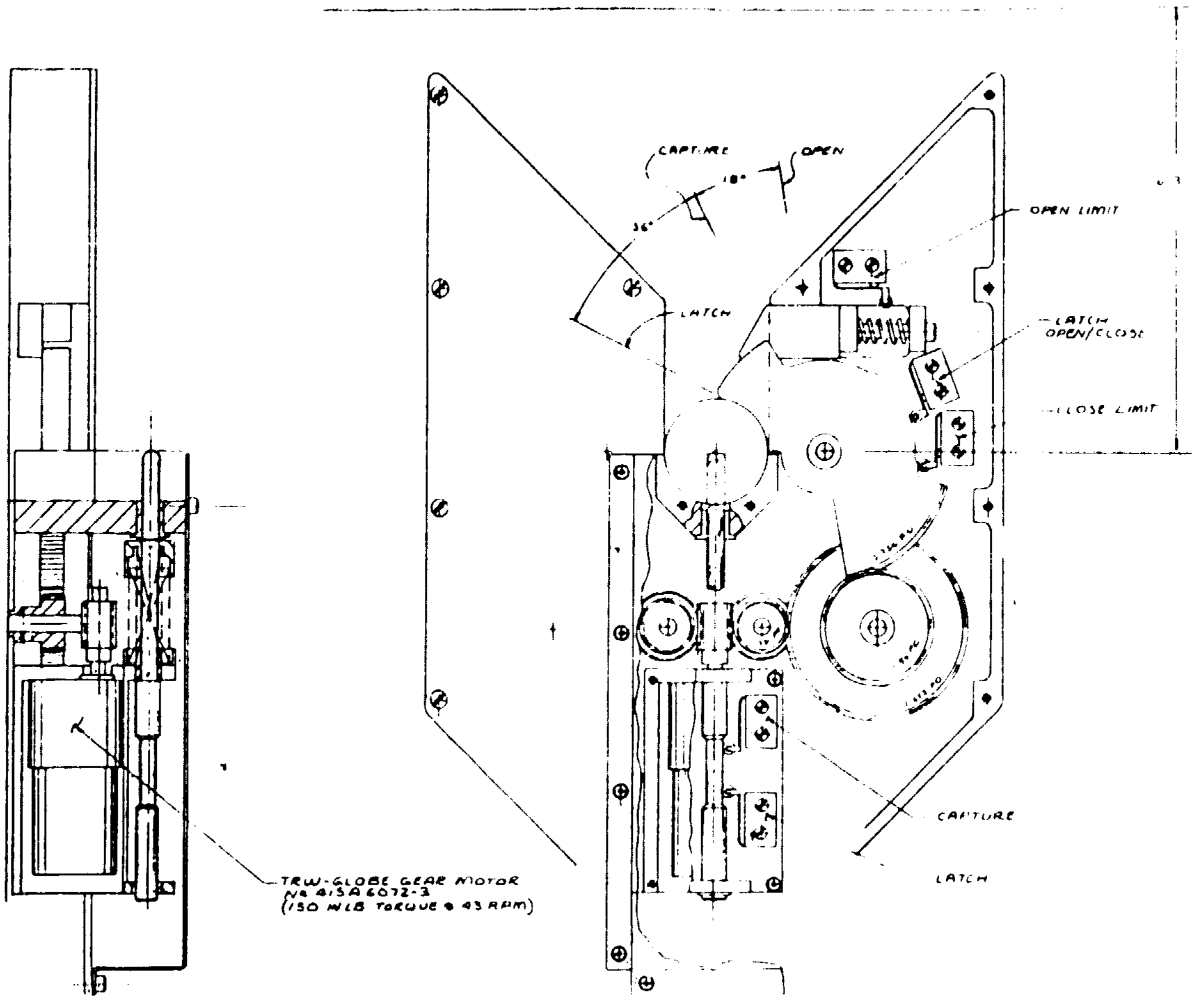

Figure 2.3: Interim Design of Docking Device

Corporation staff. The result of the PDR was approval of the general design concept with the following provisions:

a. Switches and motor selected for use on the latch would be actual flight models or physically and functionally interchangeable with flight models.

b. Hard latch indication will be via motor output, which requires the motor to survive repeated stalls.

c. Trunnion position plunger should use a small spring for capture indication and a belleville spring for latch indication and preload.

d. Change the soft capture plungers (sliding configuration) to a pivoting cam arrangement in order to reduce overall required capture force.

e. Use bearing bushings made from Kel-F, Vespel, or similar material instead of bronze.

f. The configuration of the latch should accommodate expected thermal deformation of the aft bulkhead of the Space Telescope.

The following actions were taken on the above recommendations.

a. Switches were selected which had the same footprint as those used in flight equipment but were not hermetically sealed. Essex and MSFC engineering personnel agreed that no tangible benefit would be realized from the use of flight qualifiable switches. The drive motor was changed to one which is flight qualifiable switches. The drive motor was changed to one which is flight qualifiable and is a high grade aircraft-type gear motor manufactured by TRW-Globe.

b. The use of motor output to indicate a hard latch condition was included in the new design. It can be monitored either through current drain by the motor or through a switch closure when a preset docking load is reached (see c below). The above motor and gear train configuration was selected so as not to exceed the manufacturers' recommended loads.

c. The trunnion position plunger assembly was redesigned to allow a capture indication with a depressive force of 0.45 kg hard capture. Position plunger completely depressed requires a force of 22.7 kg (Figure 2.4 and dwg. no. 478001-Spring Plunger Assembly, Appendix C).

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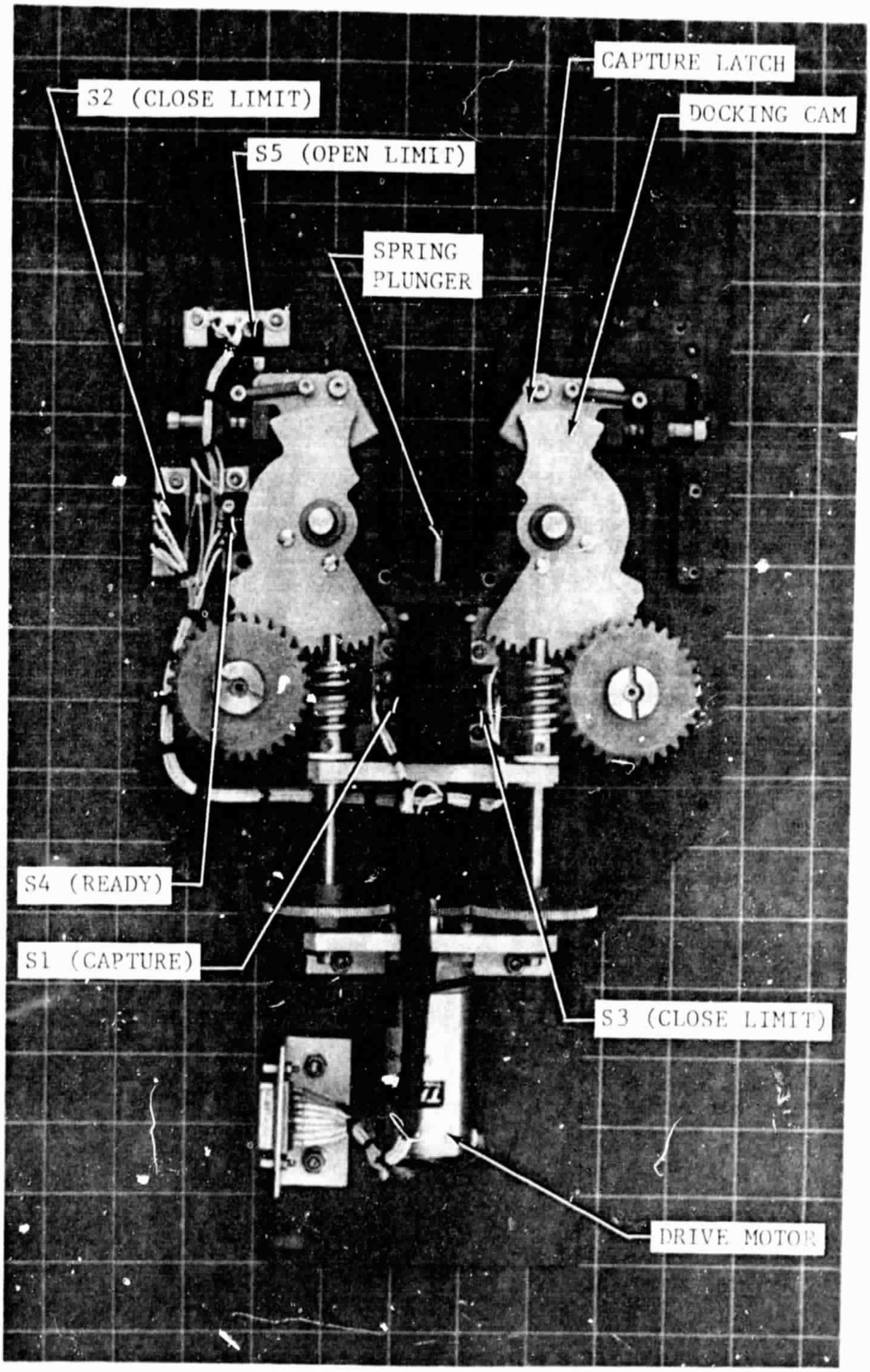

Figure 2.4: Final Configuration of Docking Device shown with Cover Removed

d. The soft capture plungers were changed to a pivoting cam arrangement as was recommended. This change resulted in a major impact on the geometry of the latch design and necessitated a reconfiguration of the drive train, gear geometry, trunnion position plunger, and location of indicator switches.

e. The recommended use of Kel-F or Vespel bearing material was not followed after consultation with the COR when it was decided that these materials provide little benefit for non-flight mechanisms when compared with more cost-effective materials.

f. The latch configuration was modified slightly to accommodate the expected 2.3 mm thermal deformation of the ST aft end. This value was obtained from MSFC engineering personnel.

2.3.2 Description of Fabricated Docking Device

The mechanical and electrical systems are detailed here to assist in analysis during integration tests and evaluations.

2.3.2.1 Mechanical Description

The final configuration of the docking device (Figure 2.4) utilizes a symetrical pair of gear-driven cams which rotate through an arc of 60° to fully retract to a position inside the latch housing. The geometry of the latches is such that once a soft capture is made, the berthing pin is within grasp of the concave surface of the pair of cams. The total linear excursion is approximately 1.6 cm. The rotational force of the cams is obtained through a gear train which includes a worm/wheel combination. A separate gear train drives each cam; however, power is provided from a common D.C. gear motor. The reduction ratio of the gearing system (excluding that internal to the motor) is 108.89:1 for each side which, when coupled with the output of the TRW Globe model 5A2313-21 gear motor, gives a theoretical nominal output torque for each cam of 490 Ncm and a theoretical stall torque of 3006 Ncm. With both cams assumed to have equal contact with a berthing pin, this would result in a nominal total docking force of 257.2 N and a limit of 1577.9 N. Because of the trunnion position plunger's opposing force of approximately 222.4 N, this would result in a total theoretical docked force of 1355.5 N. Figure 2.5 illustrates the docking sequence using a berthing pin from the MMS mockup.

An interim design utilized a differential gear assembly which was meant to equalize the rotational force between the two docking cams and also served to slow the rotational velocity of the cams. This design worked; however, positional synchronization of the two cams proved difficult and it was decided that a straight gear drive would be utilized.

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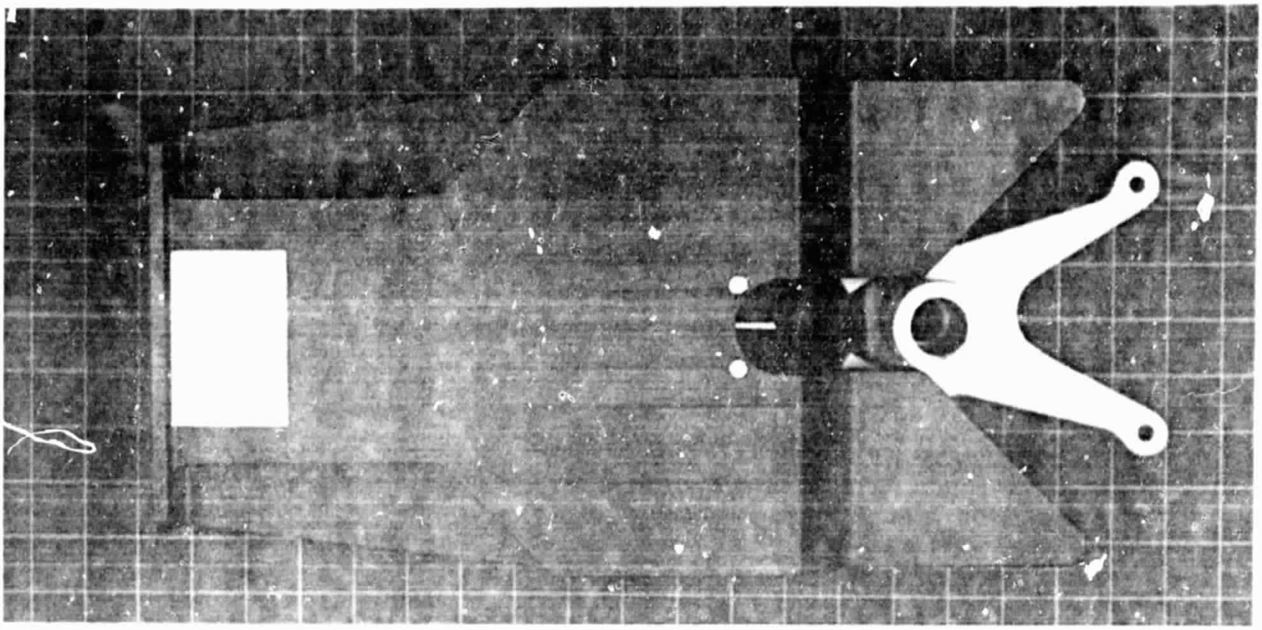
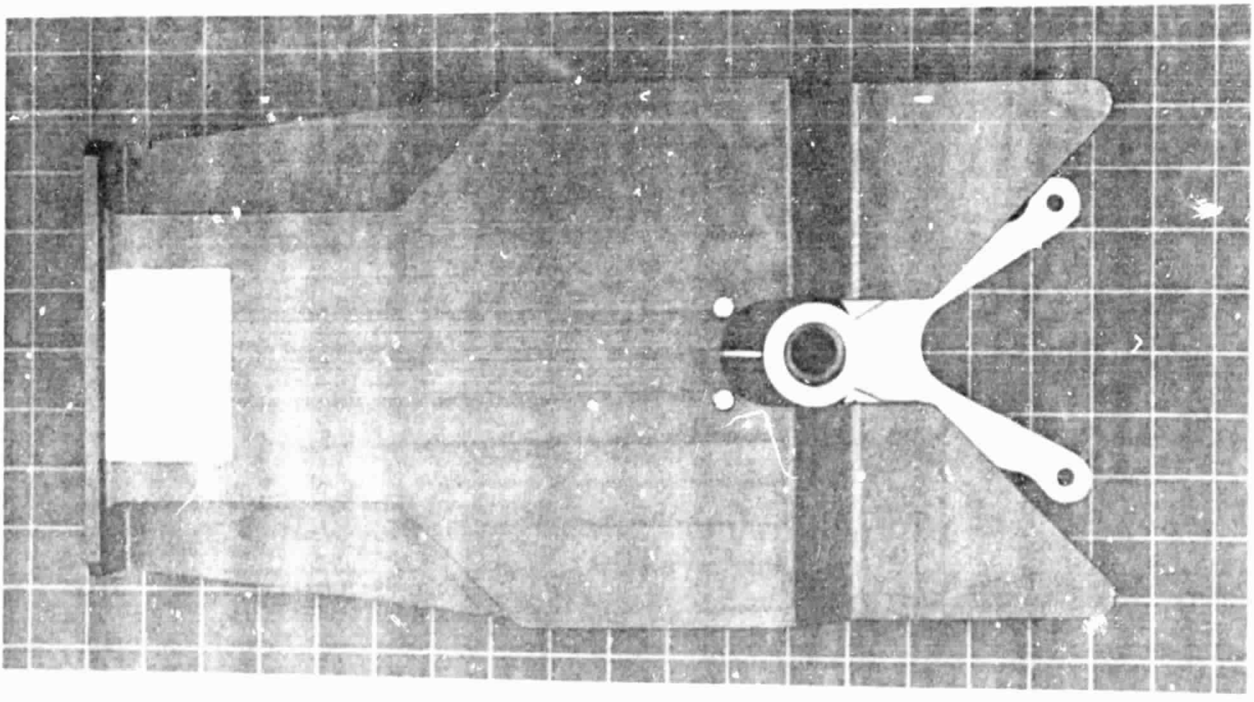
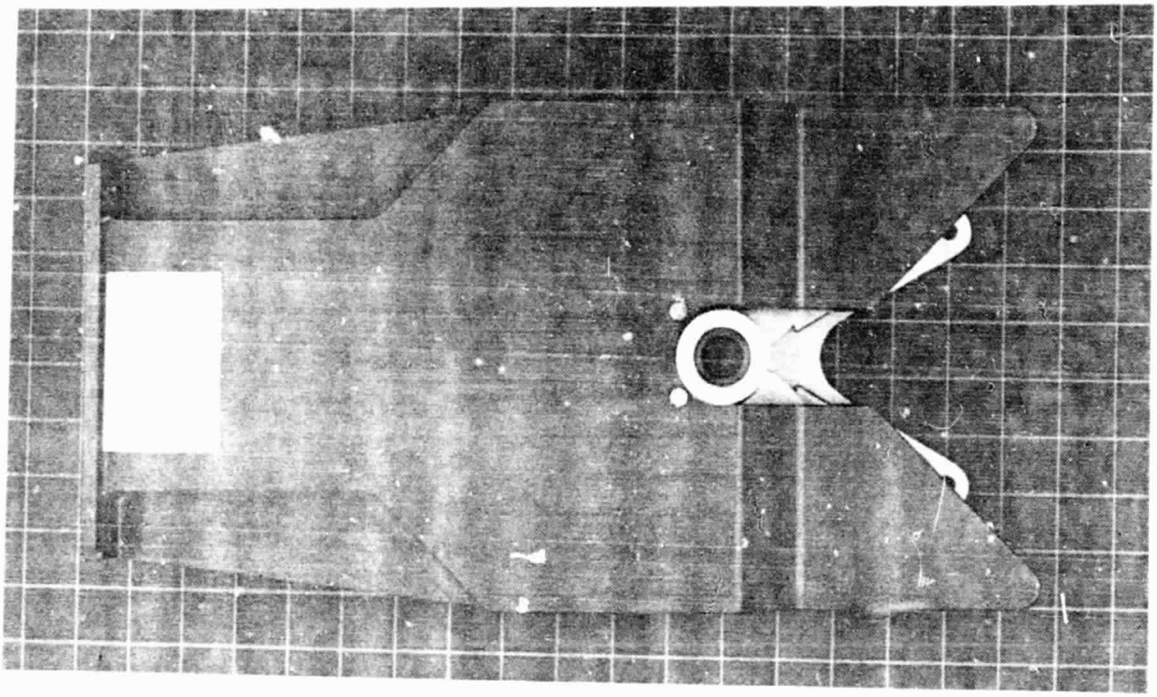


2.5a Approach of Berthing Pin



2.5b Berthing Pin Captured

Figure 2.5: Docking Device Capture and Docking Sequence



2.5c Berthing Pin Fully Docked

Figure 2.5: Docking Device Capture and Docking Sequence (cont'd)

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2.3.2.2 Electrical Description

The electric drive motor (TRW Globe model 5A2313-21) was designed for use with a 12 VDC power source. Reversal of polarity of the DC voltage results in a reversal of motor direction. Nominal current required (no load condition) is .50 amperes. Rated load (docking) is 1.2 amperes, and fully loaded (stall) is 5.1 amperes. These values were furnished by the manufacturer and may vary as a function of brush drop, field distortion, power supply, wiring, mechanical friction, etc., and should be used as guidelines in the design of control circuitry.

Each docking device is equipped with five micro switches (Figure 2.5 above) which may be wired in one of several control and/or indicator function modes. Provisions are made for the addition of three more switches for redundancy purposes. Two of the switches (S1 and S4) are used for indication purposes while the other three (S2, S3, and S5) serve as limit switches. The switch circuitry and the motor drive circuitry are electrically separated to allow the drive motor to be controlled either through a process control system or through direct limiting by utilizing the switches and diodes in a series configuration.

2.3.3 Proposed Modifications to the Docking Device

Bench testing of the three docking devices resulted in satisfactory performance of the units. No formal stress analysis was performed. It is anticipated that docking loads observed during testing may reveal deficiencies in the strength of certain mechanical components. The design itself can easily be adapted to accept higher loads with minimal impact on the geometry of the mechanism.

Prior to completion of assembly, informal docking simulations were performed using the exterior portions of the docking devices equipped with position plungers mounted on the TOM-B. These tests confirmed the effectiveness of the geometry of the docking devices and mounting structure and served as a partial proof test of the resistance of the assembly to simulated docking loads.

2.4 TASK 4 - IDENTIFICATION OF TEST REQUIREMENTS FOR THE THREE CLAW DOCKING DEVICE

The experimental and laboratory criteria for successful testing of rendezvous and docking using the three claw docking device are outlined below.

2.4.1 Test Requirements Objectives

In order to demonstrate remote docking capabilities with targets like the Multimission Modular Spacecraft and the Hubble Space Telescope, operators will be required to position and orient the Teleoperator Mobility Base with respect to the target and maintain orientation while translating to the target. The docking operation will need to be

carried out under various lighting conditions, video system configurations, closure rates and geometries, and docking hardware concepts. The identification of the types of parameters and the levels of parameters, along with the appropriate dependent measures to be collected, are the objectives of this test requirements section.

2.4.2 Operator Requirements

The test requirements concerning the remote system operators center on the representative nature of the operator pool. The operators should reflect the male and female operator population, have appropriate technical background and experience, be free of psychomotor and visual anomalies, and be adequately rehearsed on remote systems tasks to eliminate effects of learning from research findings. Other requirements include:

- o Even mix of male and female subjects,
- o Representative anthropometry,
- o Visual acuity and stereopsis tested through the Orthorator exam, color vision tested through the Pseudo Isochromatic Plate Tests,
- o Psychomotor coordination and skills tested through the Purdue Pegboard Test,
- o Translation and rotation hand controller remote system experience which measures baseline variation of less than 5% on fixed performance criteria,
- o Familiarity with operations from the Reconfigurable Work Station,
- o Familiarity with activation and deactivation of the docking mechanism,
- o Prepared operating instructions for all operators,
- o Fixed operating periods for task performance for all subjects.

2.4.3 TOM-B Requirements

The test requirements for the motion base are concerned primarily with preparation and calibration of the TOM-B prior to operations to ensure that all of the control variables are fixed and that the unit operates consistent with the design criteria. The test requirements to be met are:

- o Preload thruster and air pad air tanks to 3000 psi or another prespecified level below 3000 psi, if required,

- Verify activation of each thruster,
- Verify and record the on-board electrical power status,
- Verify bi-directional motor drives for each motor driven axis,
- Verify CTU operations and transmitter/receiver operations,
- Verify operation of on-board experimental equipment such as lights, cameras, pan/tilt units, docking devices, etc.,
- Verify correct software model and correct physical configuration of plena which reflect the software model.

2.4.4 Target Requirements

The disposition of the targets used during experiments will be test specific in terms of geometry, lighting, docking targets, etc., but the general requirements for every target used will include the following:

- For fixed targets, verify that the target is secured to the target mount and that all bolts, nuts and break away structures are in place. Verify that the target mount is securely attached to the floor or other pedestal.
- For moveable targets, verify that the target is securely mated to the standard mounting plate and that the appropriate counter weights are securely installed. Verify the bi-directional motor drives for each axis requiring motion. For targets mounted on the target motion system, verify that the low pressure air umbilical is properly connected and that the air flow regulator is correctly set.
- Verify that experiment peculiar subsystems are correctly mounted and set. These would include docking targets, docking probes, target geometries and positions, antennas and solar arrays.
- Verify and calibrate any on-board data recording devices.

2.4.5 Environmental Requirements

The condition of the laboratory environment in which experiments are conducted is critical to the validity and reliability of the experimental data. Those variables which require conditioning and recording are:

- Air Flow - all air handling equipment should be turned off to prevent air currents from confounding the experimental findings.

- o Ambient Lighting - all lighting systems not required as part of the experimental design should be turned off.

- o Airbearing Epoxy Floor - this should be cleaned with isopropol alcohol and a clean mop prior to each test run.

- o Access - the laboratory spaces should be secured and signs posted stating that testing is being conducted and that entry is not permitted. Access to the operator's control room must also be restricted.

- o Communications - verify the communications network, including experimenters' communications and isolation of the operator's communication during tests.

2.4.6 Data Requirements

For each of the experiments run in the laboratory, the data requirements are the most significant factor to consider. The independent, dependent and control measures must be carefully identified prior to actually running any experiments. The use of these data, in the form of a multivariate statistical analysis, must also be defined prior to data collection. This will assure that the type of data being collected and the analyses are appropriate to one another and will yield useful design or engineering data at the conclusion of the experimental run. The minimal dependent data requirements will be of the form:

- o Performance time - time to complete whole and specific part tasks.

- o Performance error - deviations from prespecified performance criteria.

- o Resources expenditure - the amount of expendable resources used during a particular task.

There are variations on each of these measures such as direction and amplitude of errors, temporal and spatial distributions, etc., which would be appropriate to specific evaluations.

3.0 CONCLUSIONS AND RECOMMENDATIONS

All contract tasks were performed as planned and the contract end items, including three claw docking device, ST mockup and MMS mockup, were delivered and installed in MSFC Building 4619.

This hardware provides the Teleoperator and Robotics Evaluation Facility with the capability to simulate docking with observatory class spacecraft (i.e. ST) and MMS class spacecraft. These two classes of freeflyers represent the majority of spacecraft anticipated in the 1985-2000 timeframe and will likely be the object of the majority of docking studies.

However, neither the ST or MMS mockups have the capability to simulate continuous, controlled 360° roll which the spin stabilized spacecraft will require. To more accurately duplicate the docking tasks for these spacecraft, this roll capability should be developed as preliminary docking studies are performed on the current mockups.

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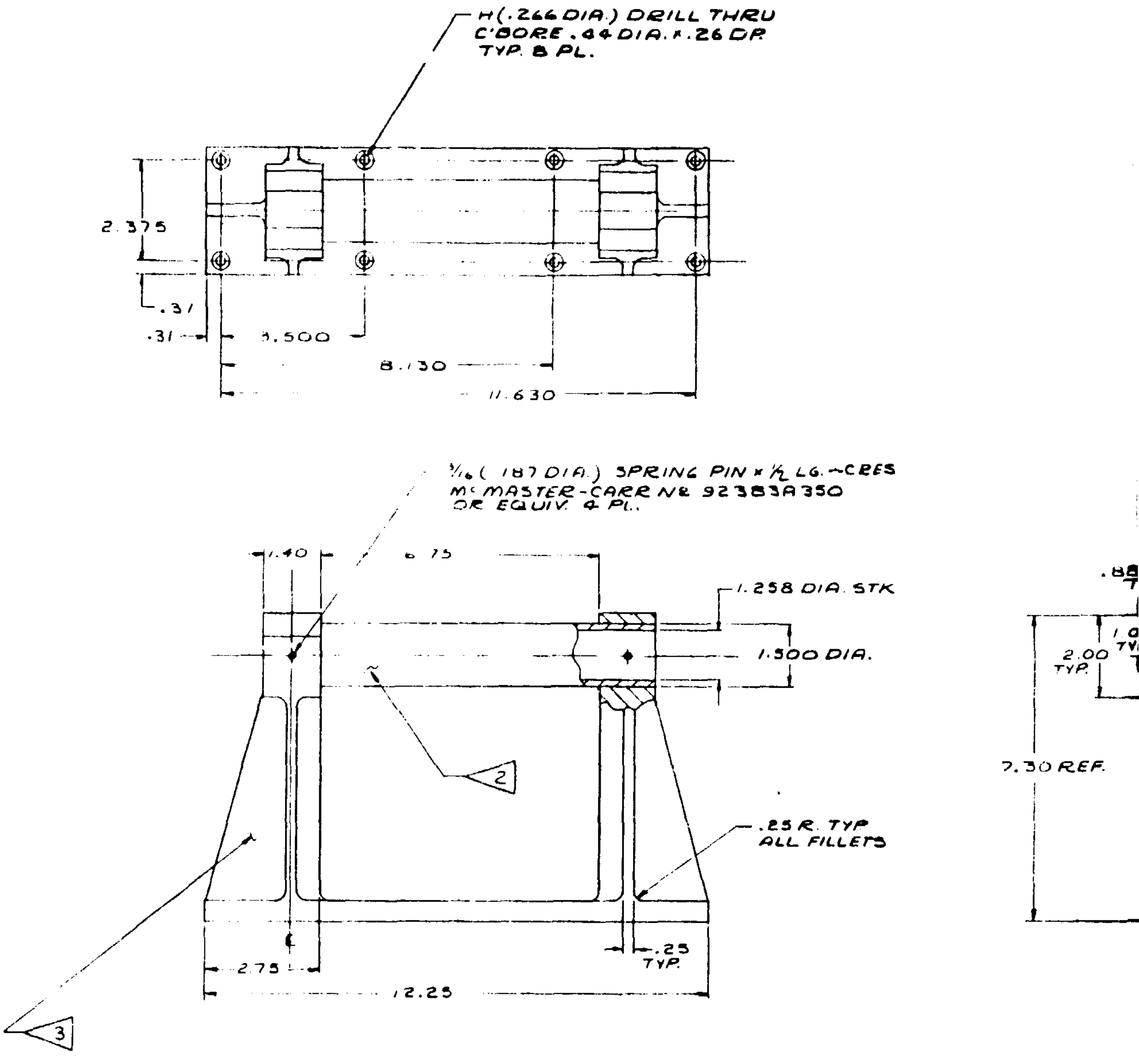
APPENDIX A: Drawings of Space Telescope Mockup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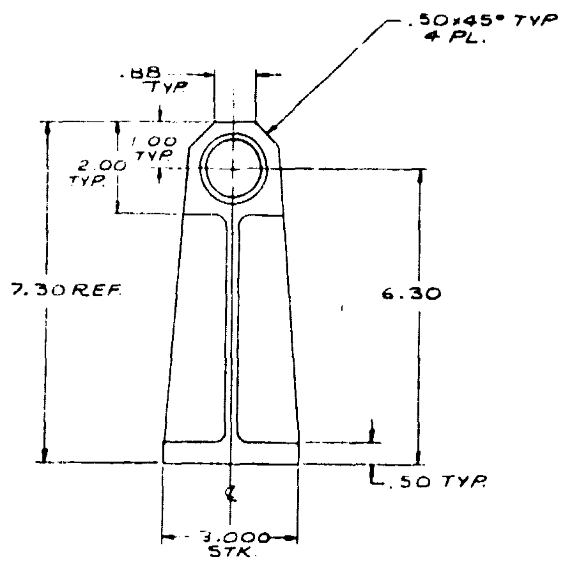

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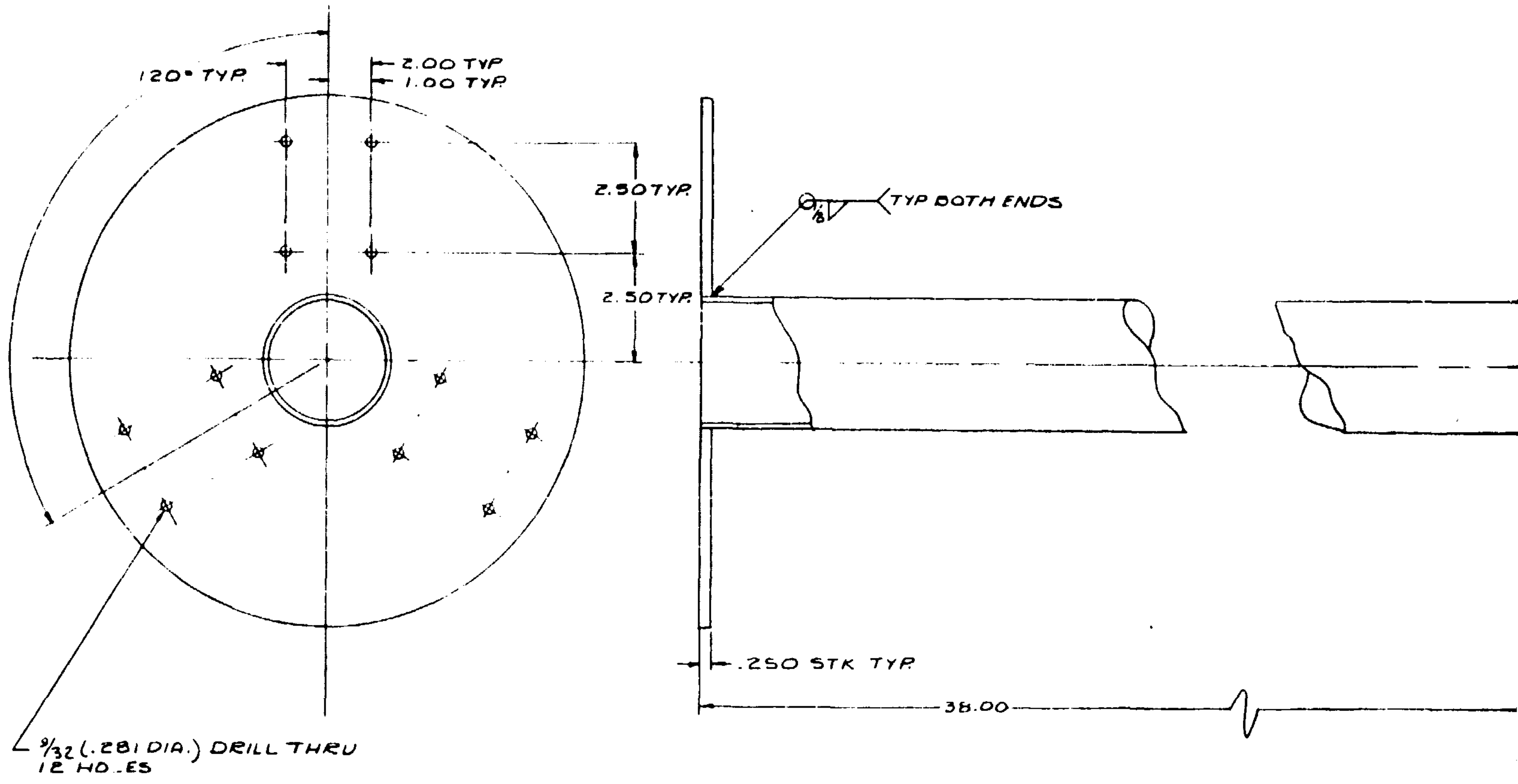

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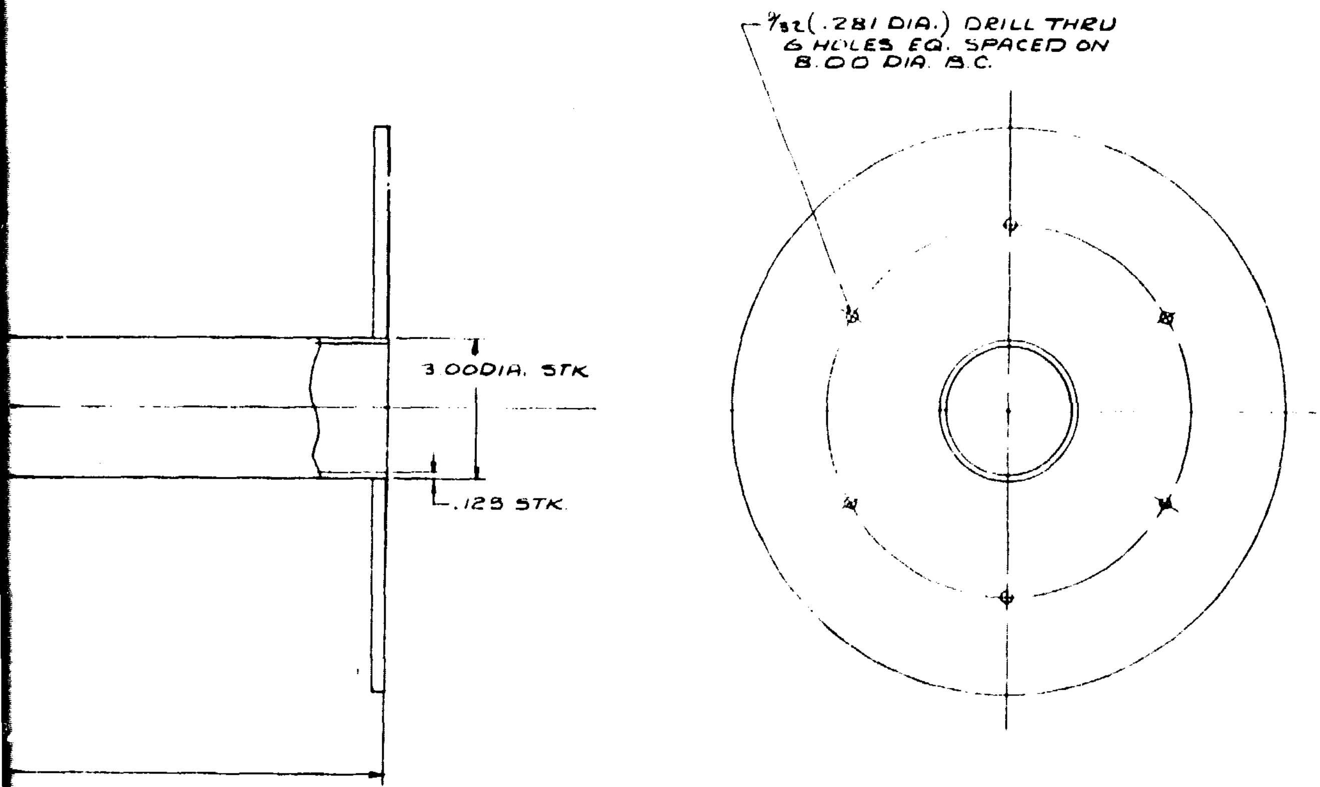

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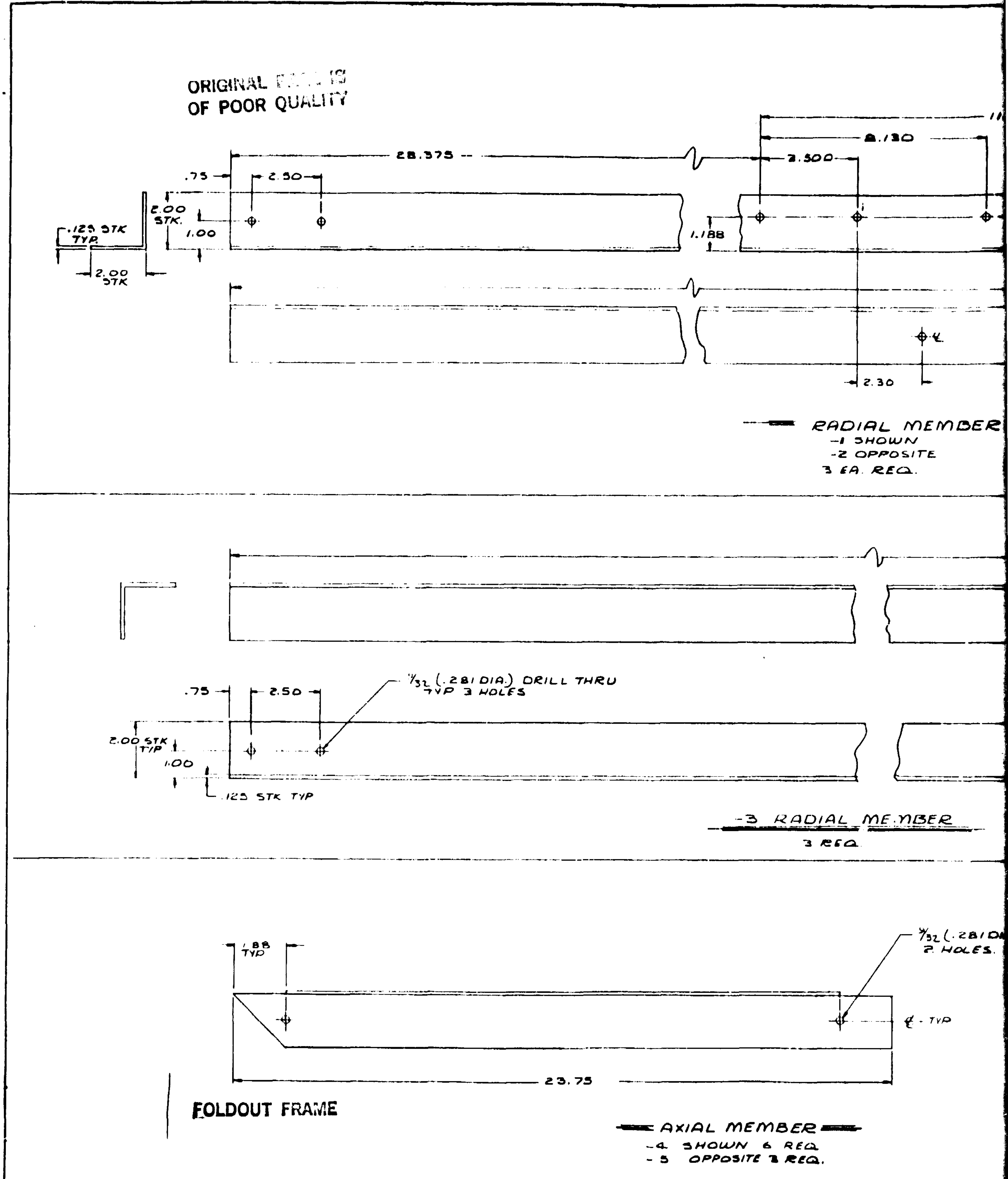

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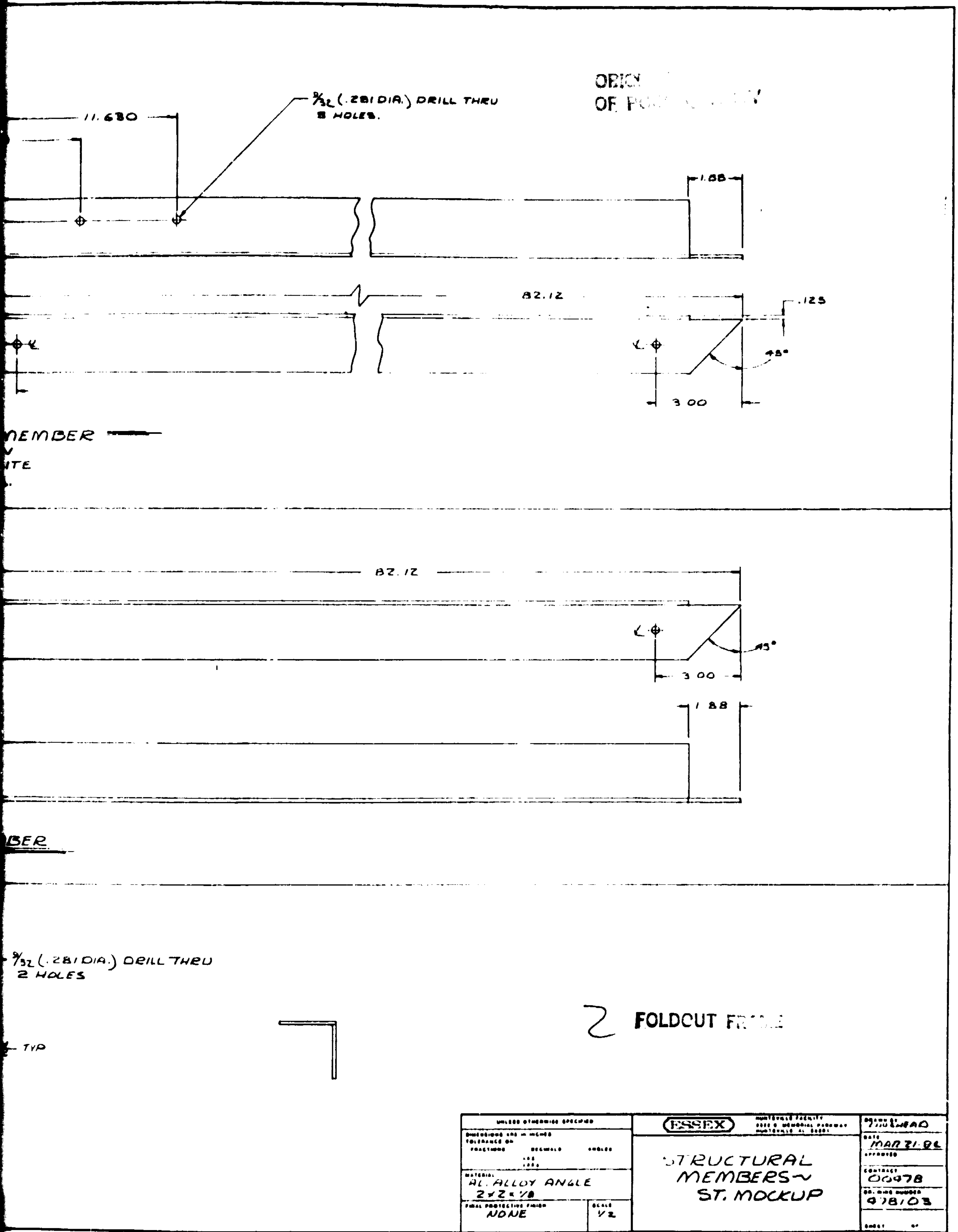

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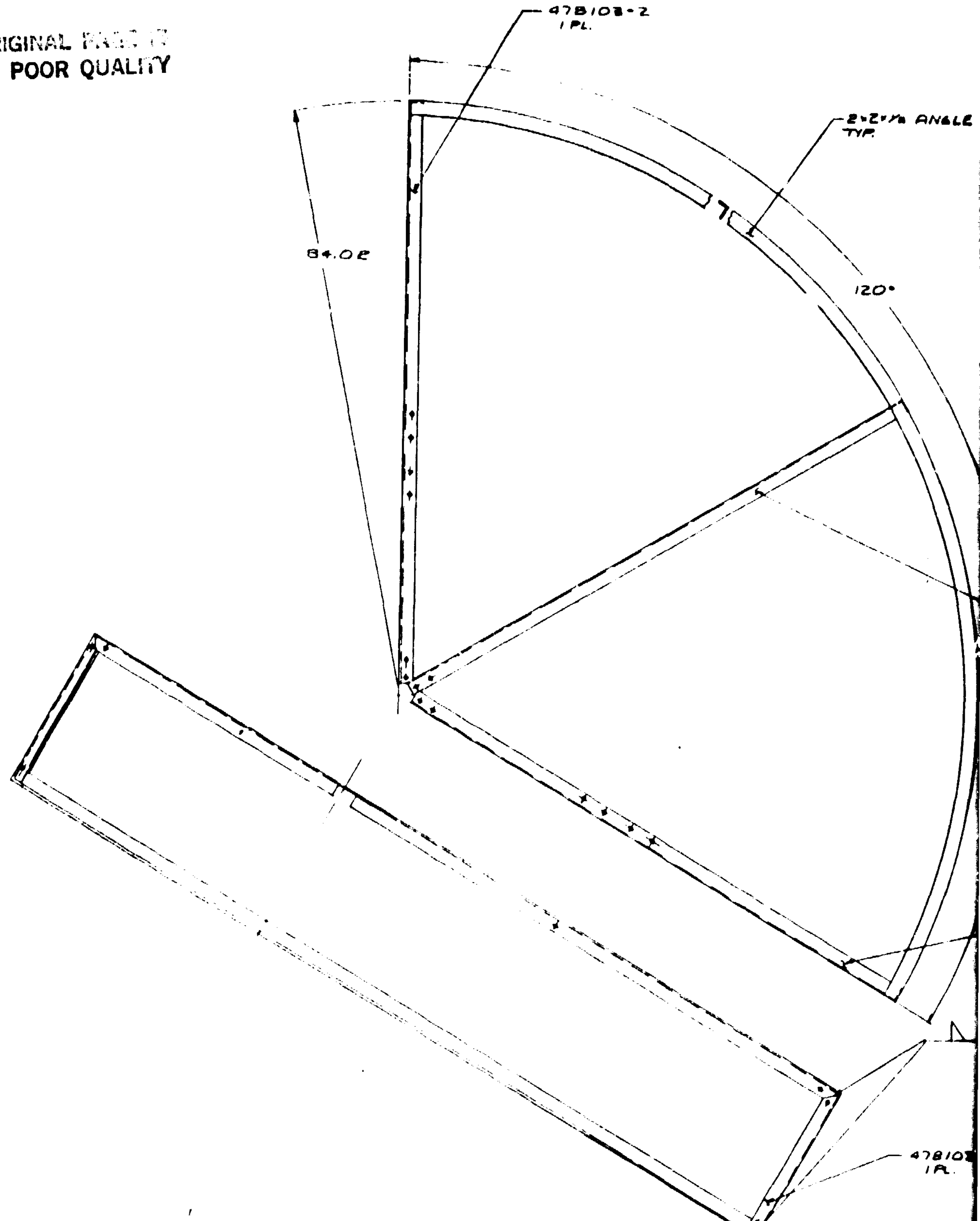

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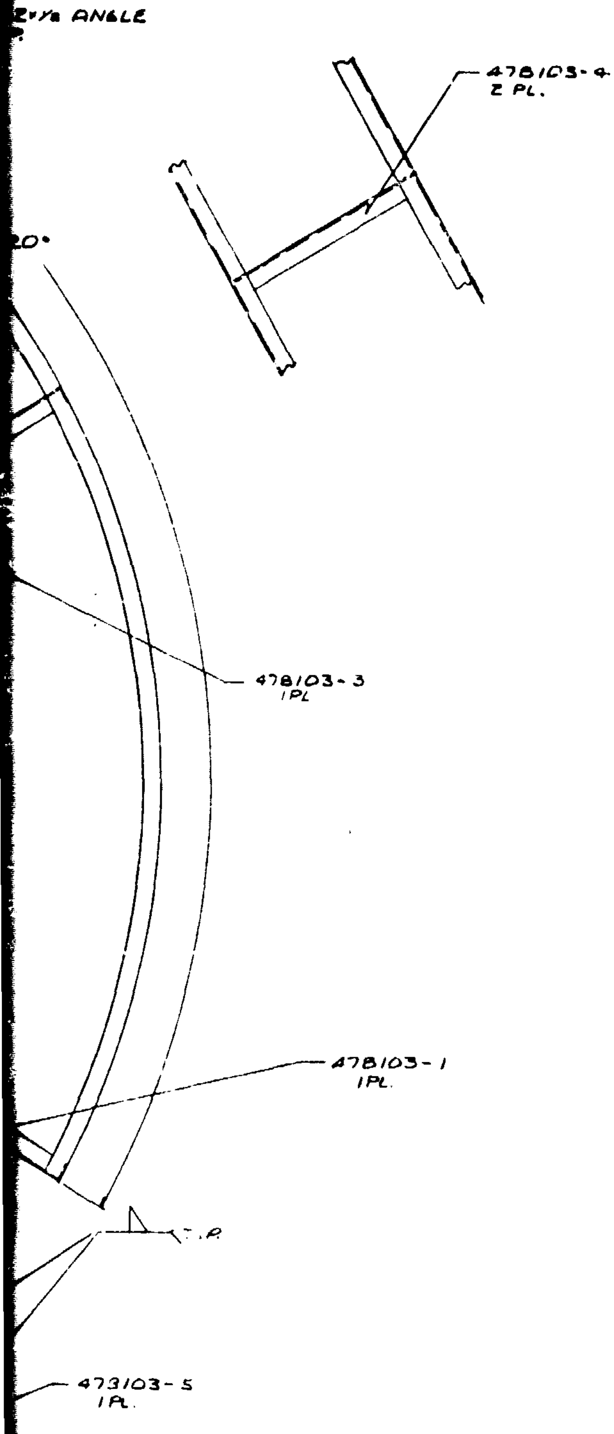

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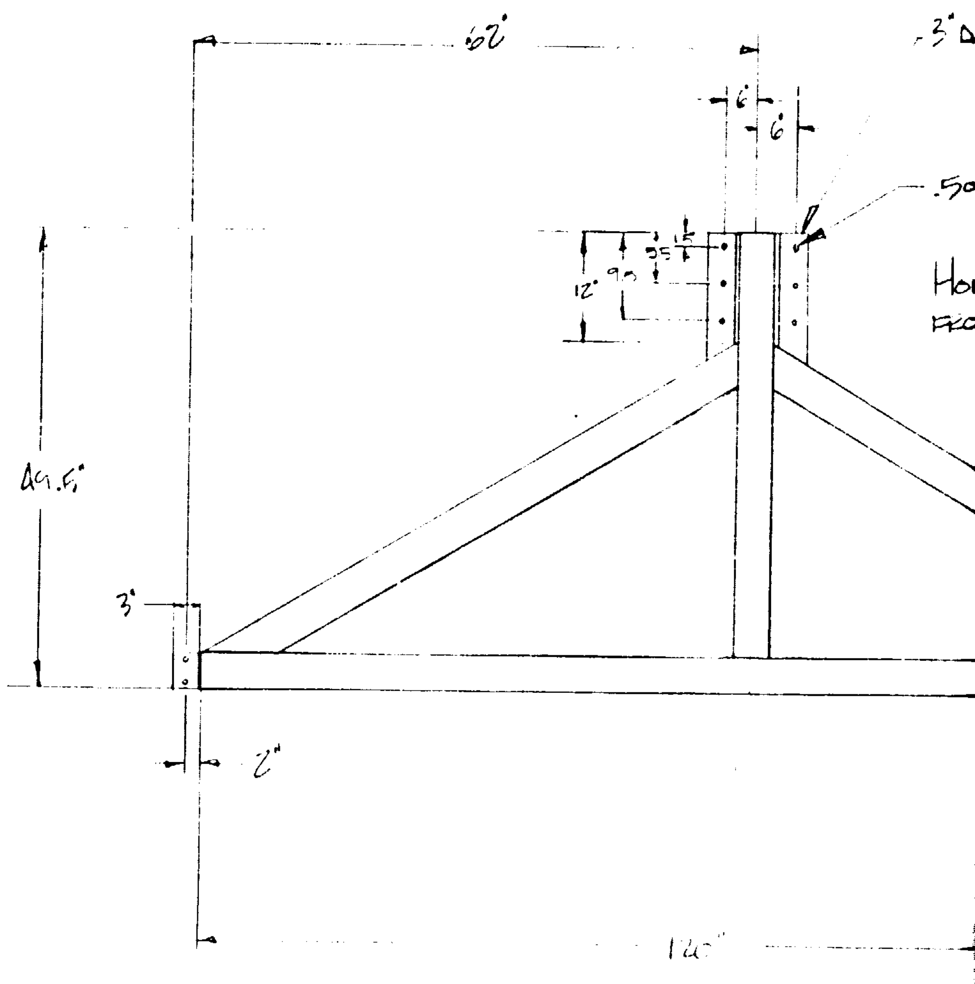

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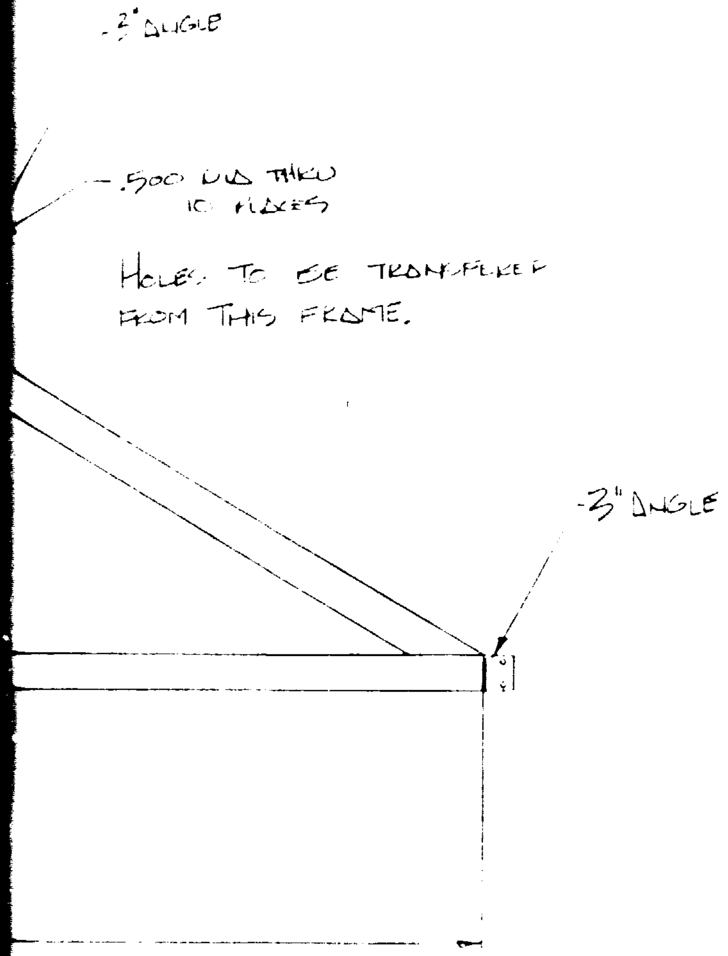

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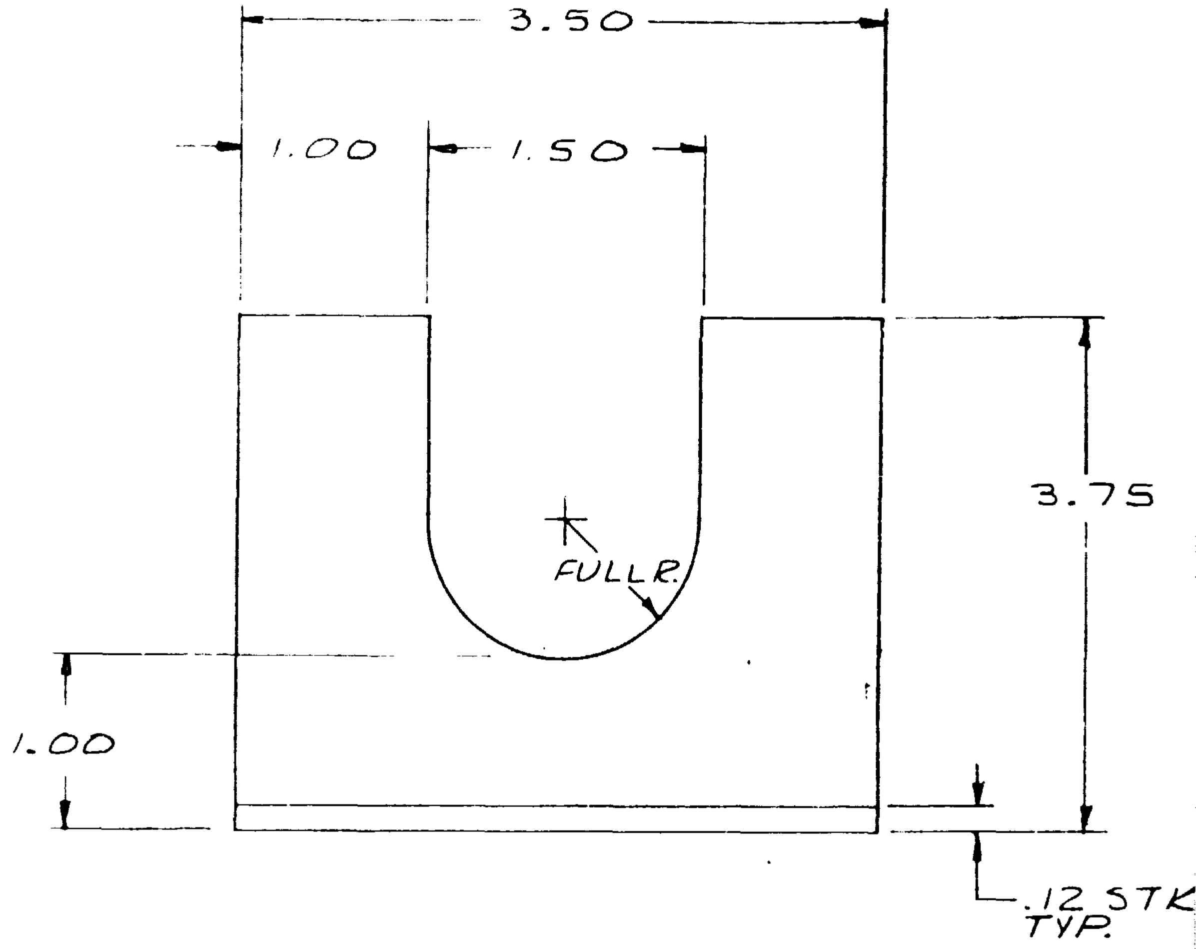
UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, MEMORIAL PARKWAY, HUNTSVILLE AL	DRAWN BY
DIMENSIONS ARE IN INCHES. TOLERANCE ON FRACTIONS / DECIMALS / ANGLES	ST SUPPORT FRAME FOOT PRINT	DATE
MATERIAL ~		APPROVED
FINAL PROTECTIVE FINISH ~ / SCALE ~		CONTRACT
		DRAWING NUMBER 478105
		SHEET OF



UNLESS OT

DIMENSIONS ARE IN
TOLERANCE ON
FRACTIONS
~
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ALUM. A

FINAL PROTECTIVE F
NONE

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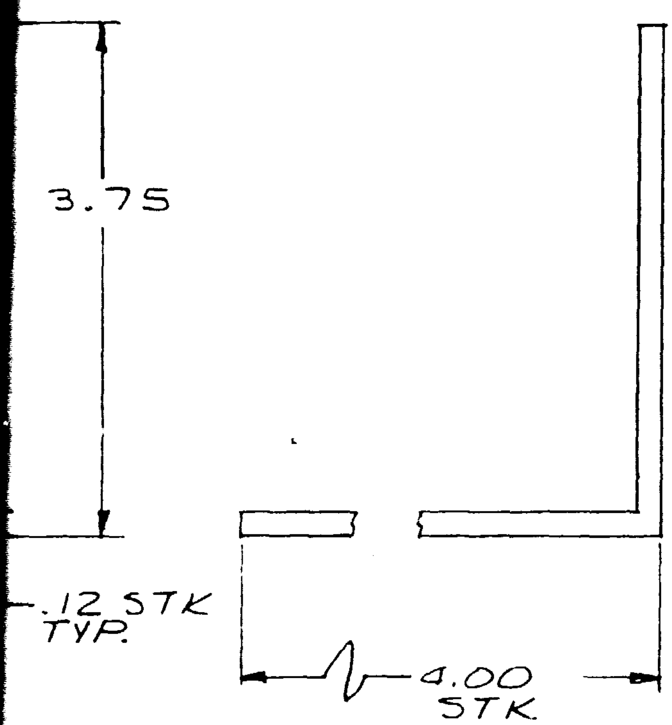

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ · DECIMALS XX ± .06, XXX ± ~ · ANGLES ~	ESSEX · HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
MATERIAL ALUM. ALLOY	HANDRAL BKT~ ST. MOCKUP	DATE 5-21-82
FINAL PROTECTIVE FINISH NONE · SCALE 1-1		APPROVED [signature]
		CONTRACT 00478
		DRAWING NUMBER 478106
		SHEET OF

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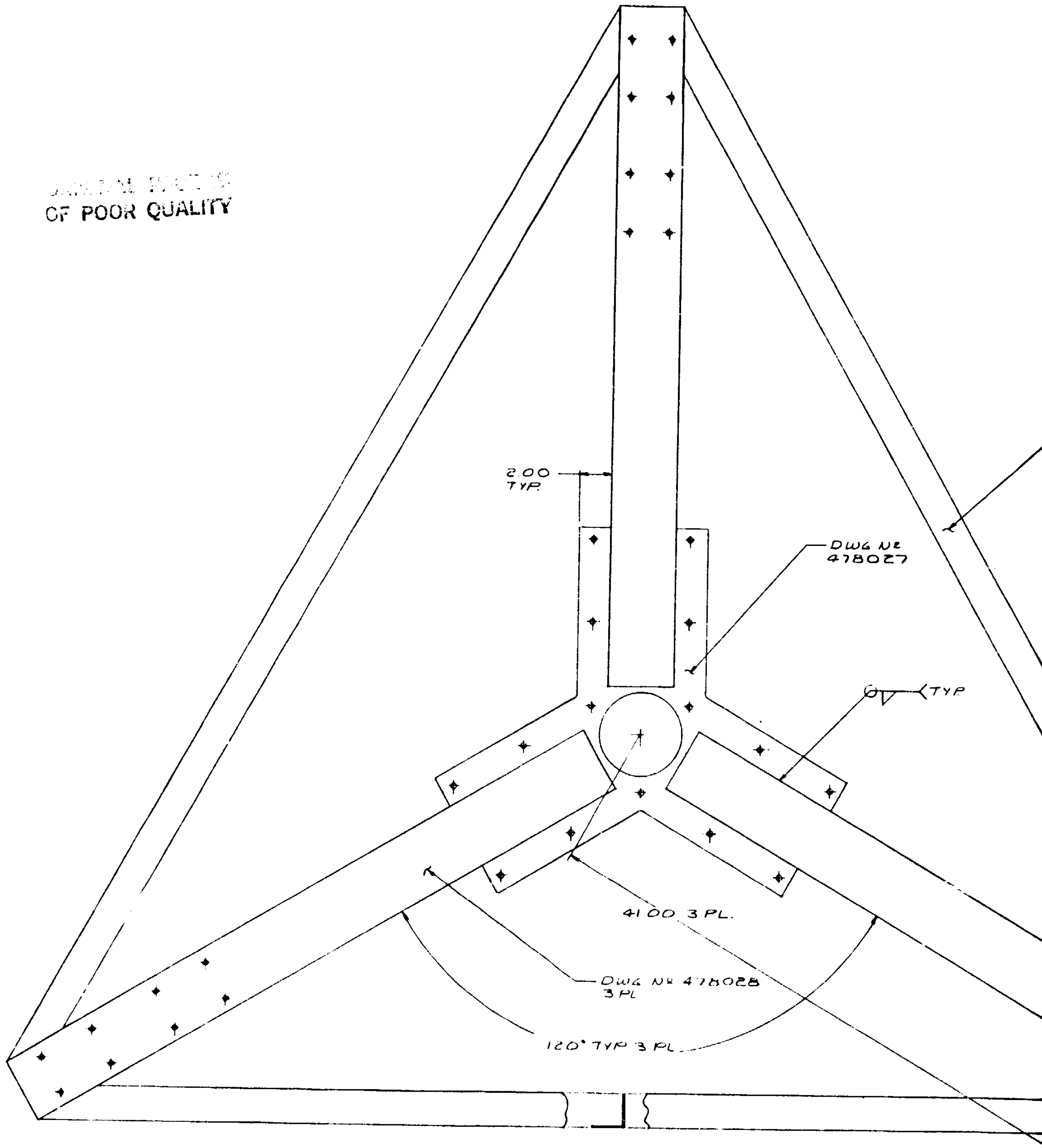

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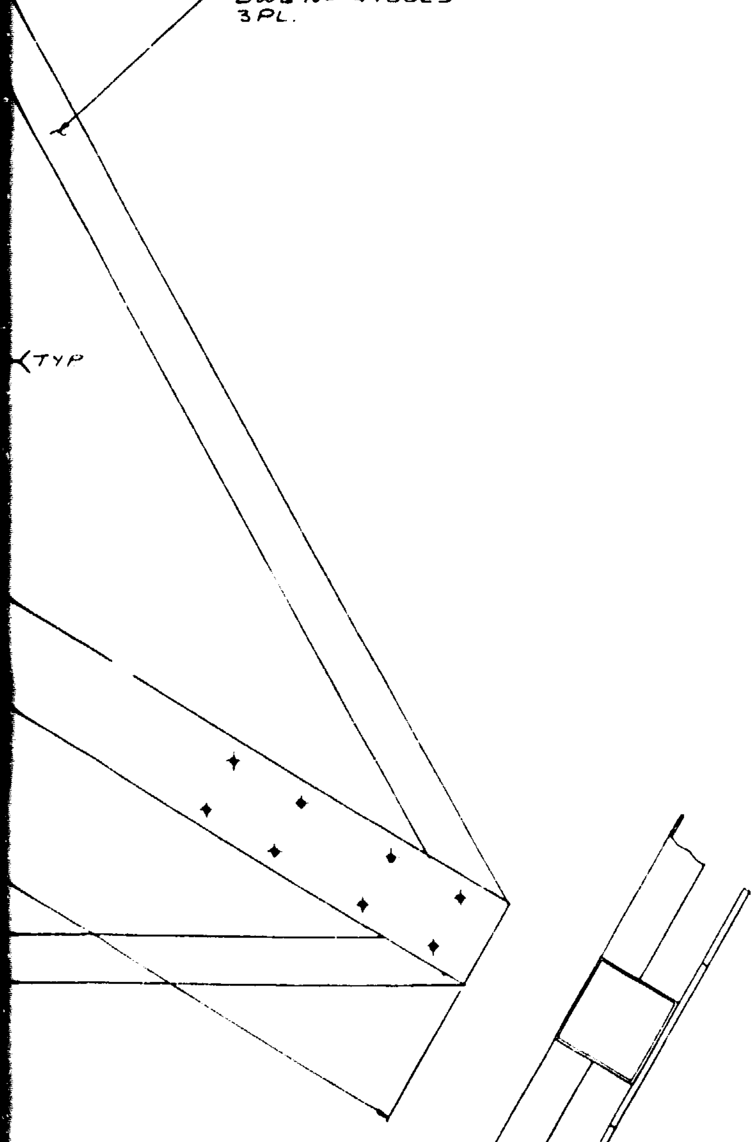

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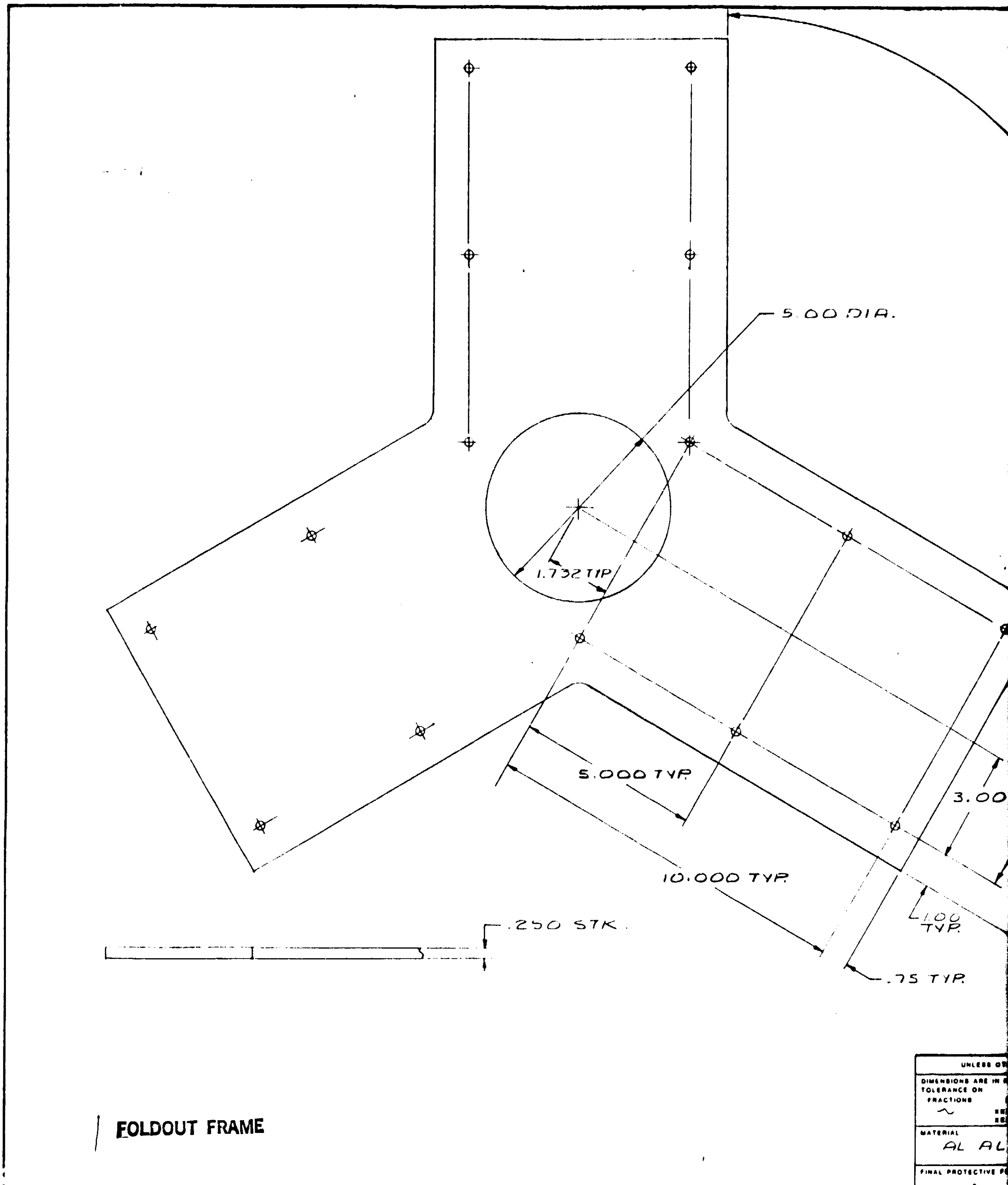
UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, [illegible] S. MEMORIAL PARKWAY, HUNTSVILLE AL [illegible]	DRAWN BY: IWSHEAD
DIMENSIONS ARE IN INCHES. TOLERANCE ON: FRACTIONS ~ ; DECIMALS ±.030 ; ANGLES	BERTHING PIN SUPPORT ASSY	DATE: 8-21-84
		APPROVED
MATERIAL: NOTED		CONTRACT: OCK78
FINAL PROTECTIVE FINISH: NONE ; SCALE: 1/2		DRAWING NUMBER: 478030
		SHEET OF



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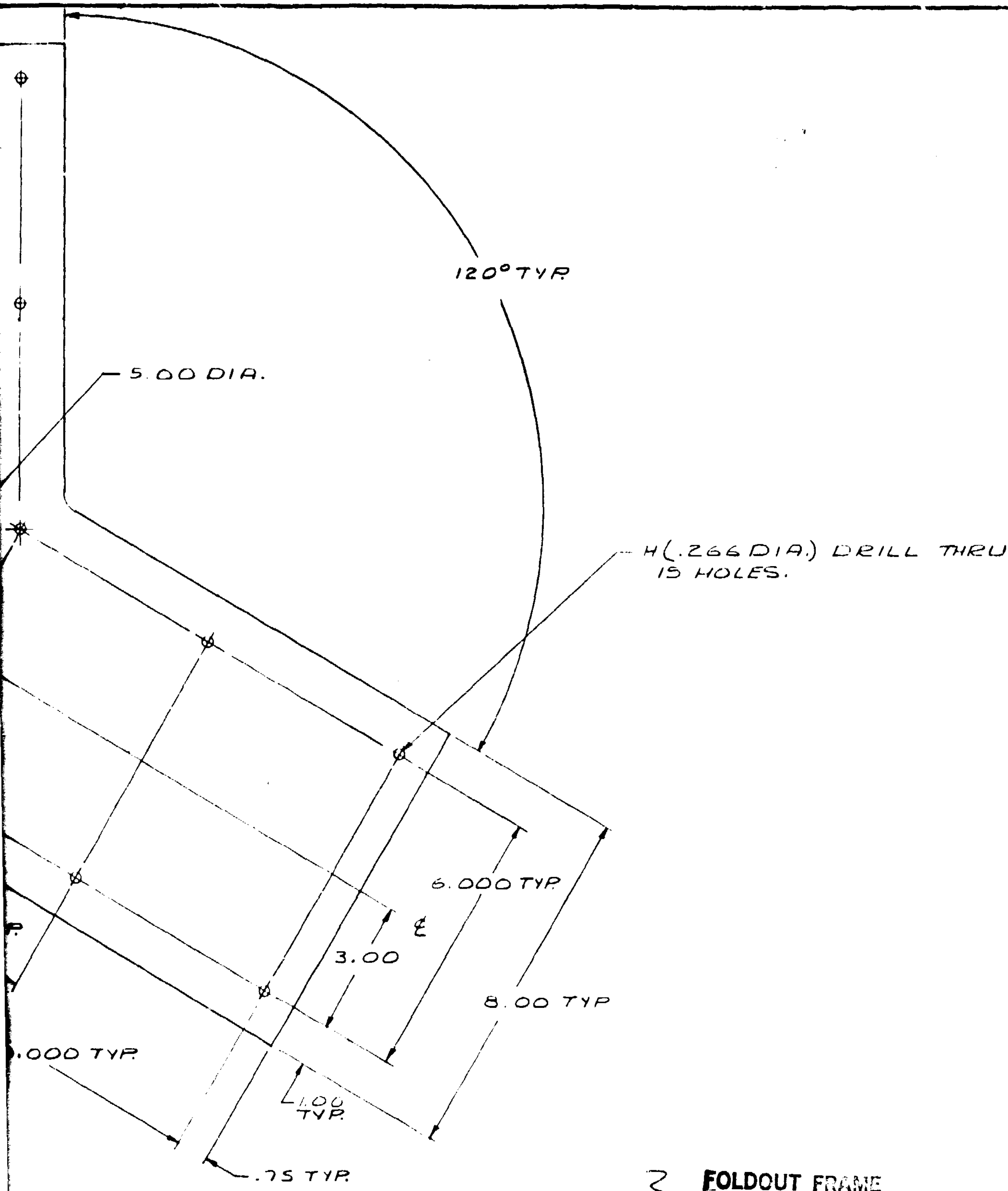

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ DECIMALS .XX ±.015 .XXX ±.005 ANGLES 15'	ESSEX HUNTSVILLE FACILITY 8322 S. MEMORIAL PARKWAY HUNTSVILLE AL 35801	DRAWN BY LOUGHEAD DATE AUG 20-84 APPROVED
MATERIAL AL ALLOY	MOUNTING PLATE	CONTRACT 00478 DRAWING NUMBER 478027
FINAL PROTECTIVE FINISH ~ SCALE 1/2		SHEET OF

ORIGINAL PAGE IS
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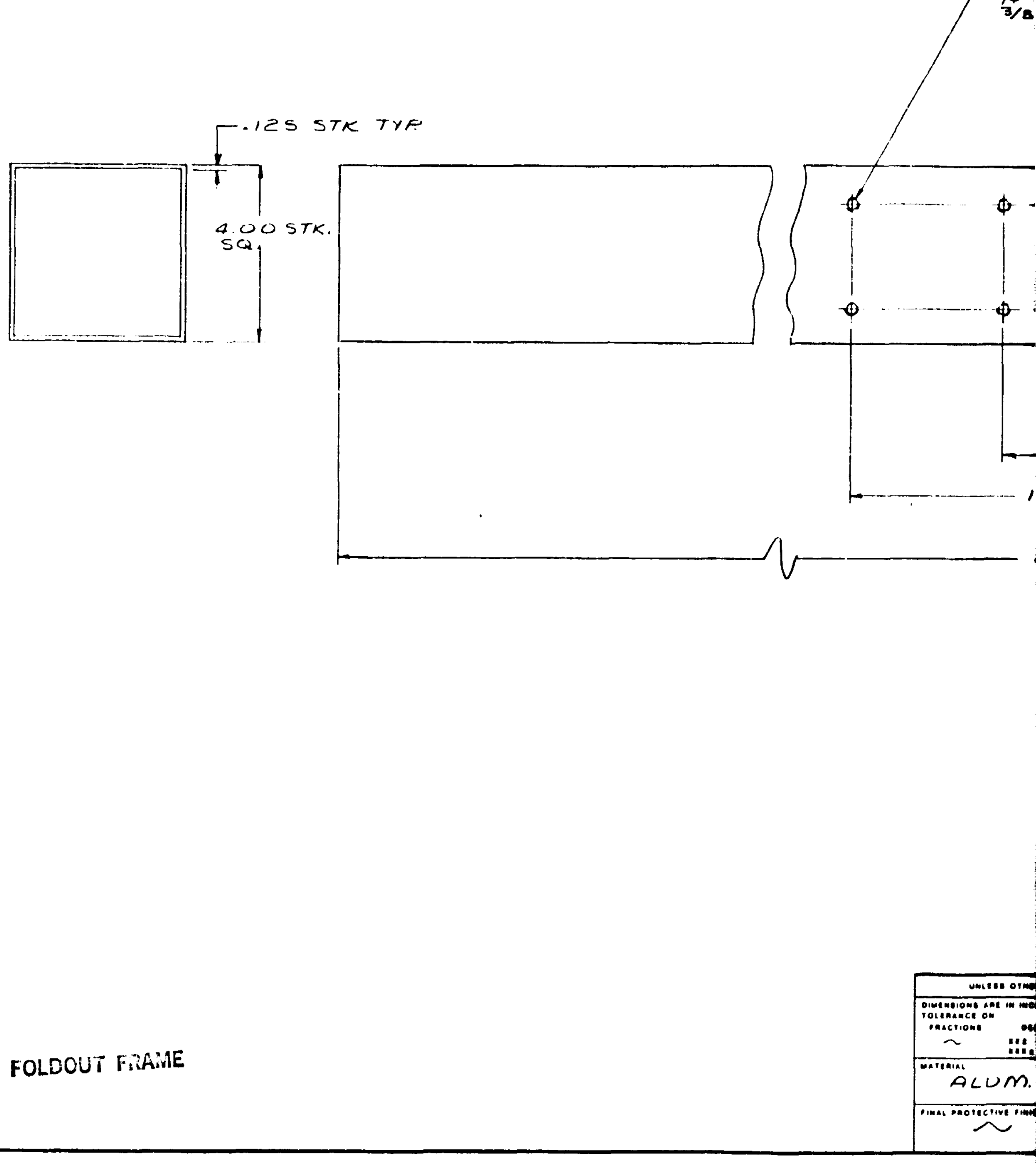

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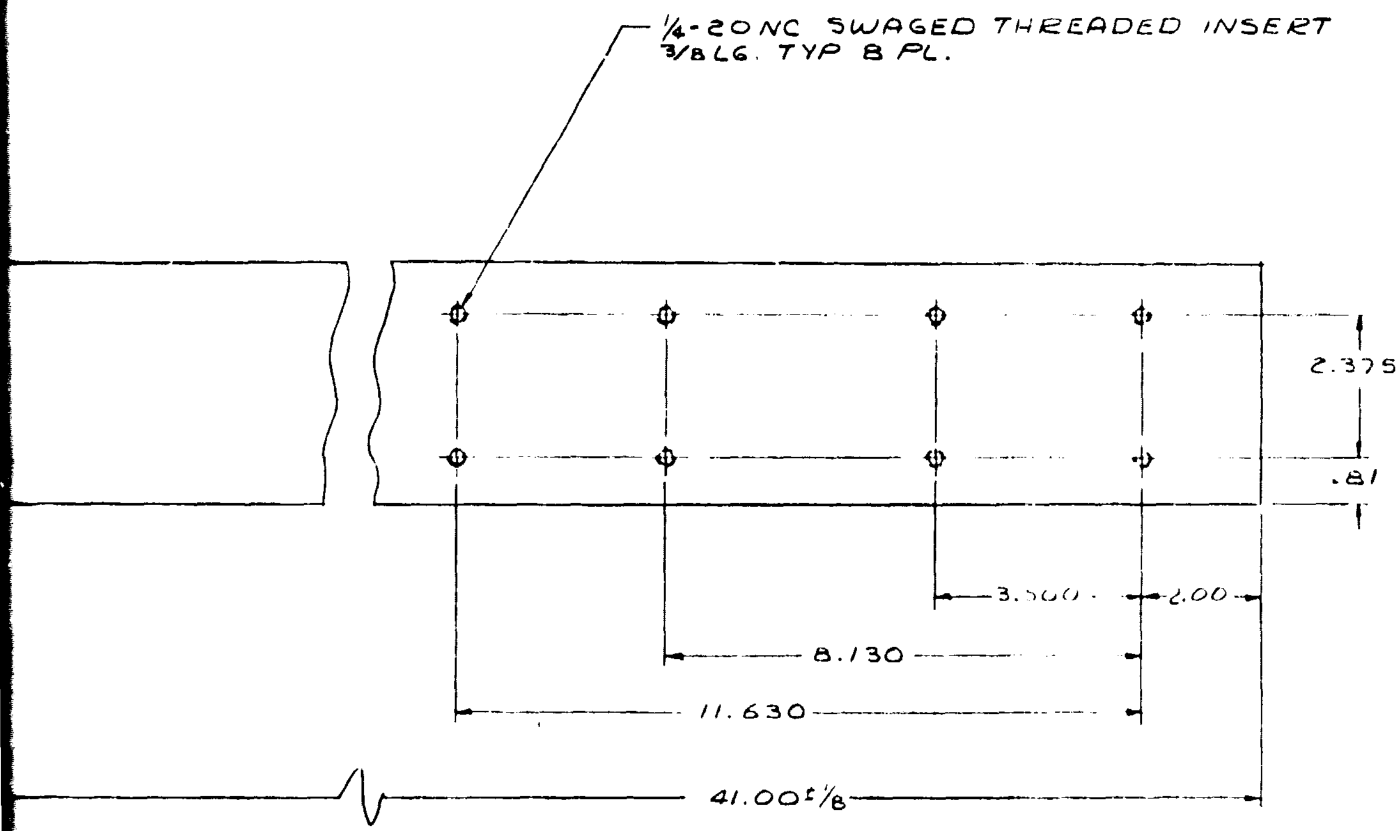

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ DECIMALS .xx ±.015 .xxx ±.005 ANGLES ~	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE AL 35801	DRAWN BY LOUGHEAD
	SUPPORT ARM	DATE AUG 20 '84
		APPROVED
MATERIAL ALUM. ALLOY		CONTRACT 00478
		DRAWING NUMBER 478028
FINAL PROTECTIVE FINISH ~ / SCALE 1/2		SHEET OF

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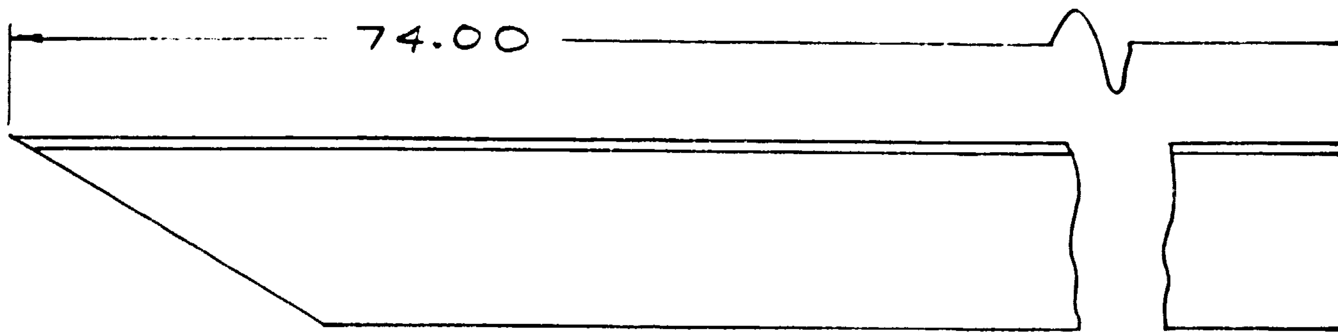

UNLESS OTH

DIMENSIONS ARE IN IN
TOLERANCE ON
FRACTIONS DE
XX±
XXX±

MATERIAL
ALUM.

FINAL PROTECTIVE FIN
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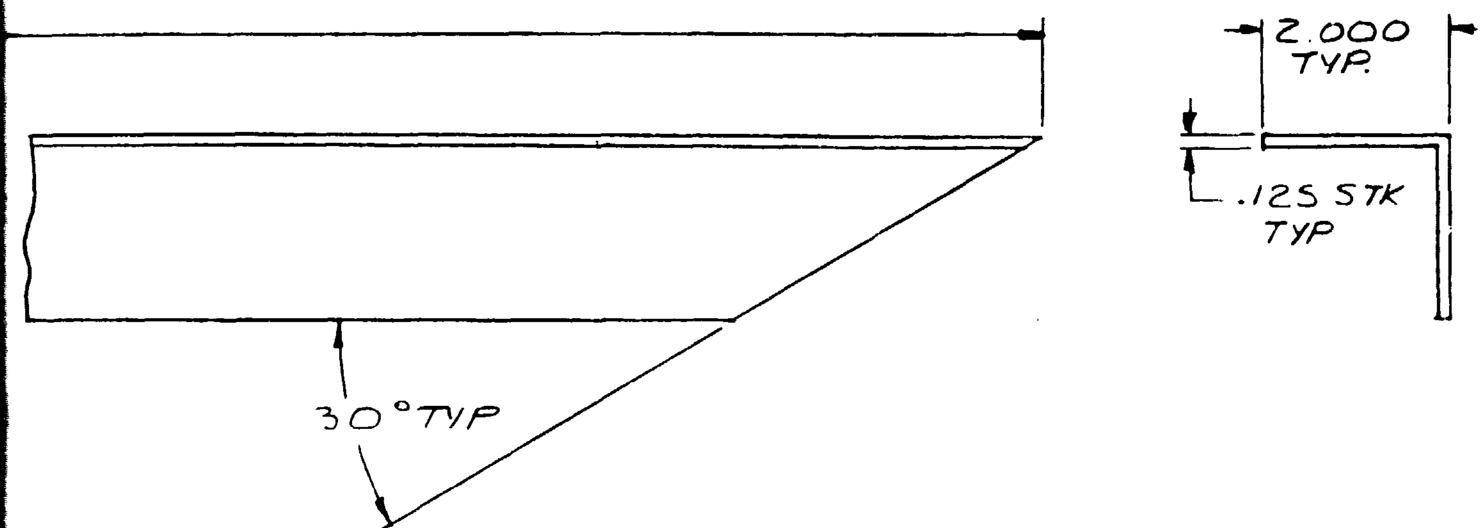

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UNLESS OTHERWISE SPECIFIED [DIM]ENSIONS ARE IN INCHES [TOL]ERANCE ON [FR]ACTIONS — DECIMALS XX ± .03, XXX ± ~ — ANGLES ½°	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL 35801		DRAWN BY: LOUGHEAD
	BRACE		DATE: AUG. 20-84
[MAT]ERIAL: ALUM. ALLOY			APPROVED:
[FIN]AL PROTECTIVE FINISH: ~	SCALE: ½		CONTRACT: 00478
			DRAWING NUMBER: 478029
			SHEET OF

ESSEX

APPENDIX B: Drawings of MMS Mockup

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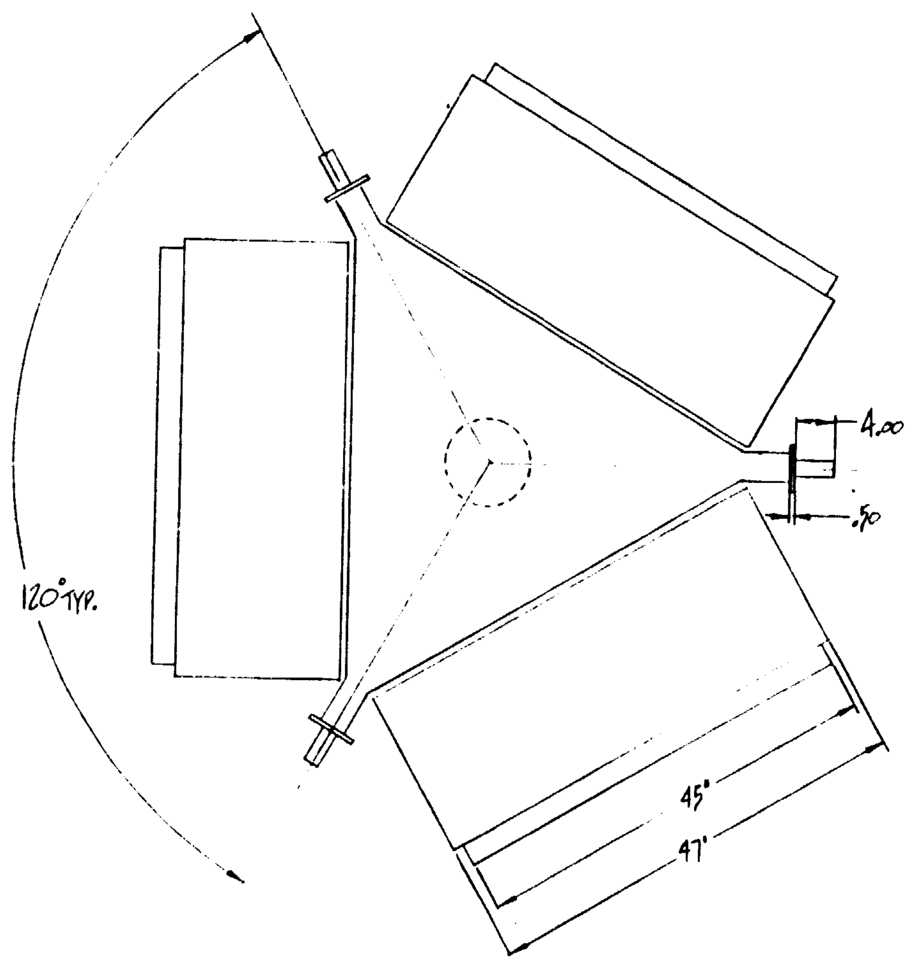

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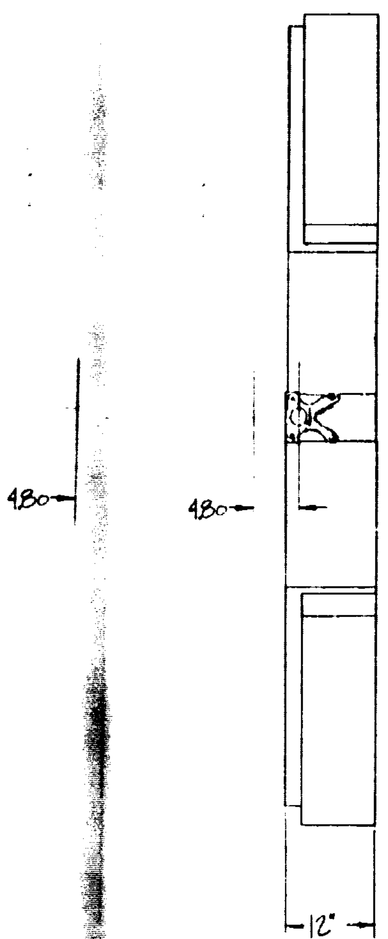

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES	ESSEX HUNTSVILLE FACILITY	DRAWN BY RVW DATE 3-22-84 APPROVED
MATERIAL ALUM., FOAM CORE	SOLAR MAX - T/O. TARGET ASSEMBLY	CONTRACT 00478 DRAWING NUMBER 478106
FINAL PROTECTIVE FINISH ALUM. FOIL — SCALE 1"=10"		SHEET OF

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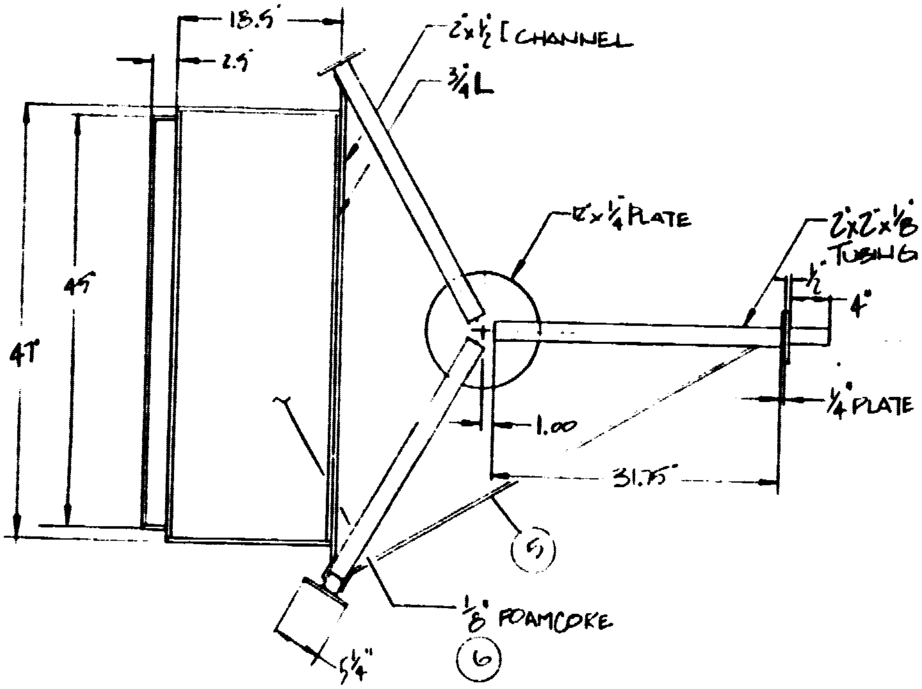

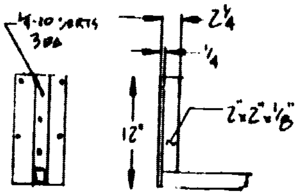

DETAIL (1)
ASSEMBLY

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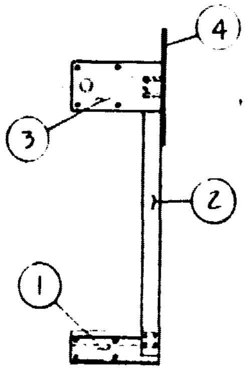

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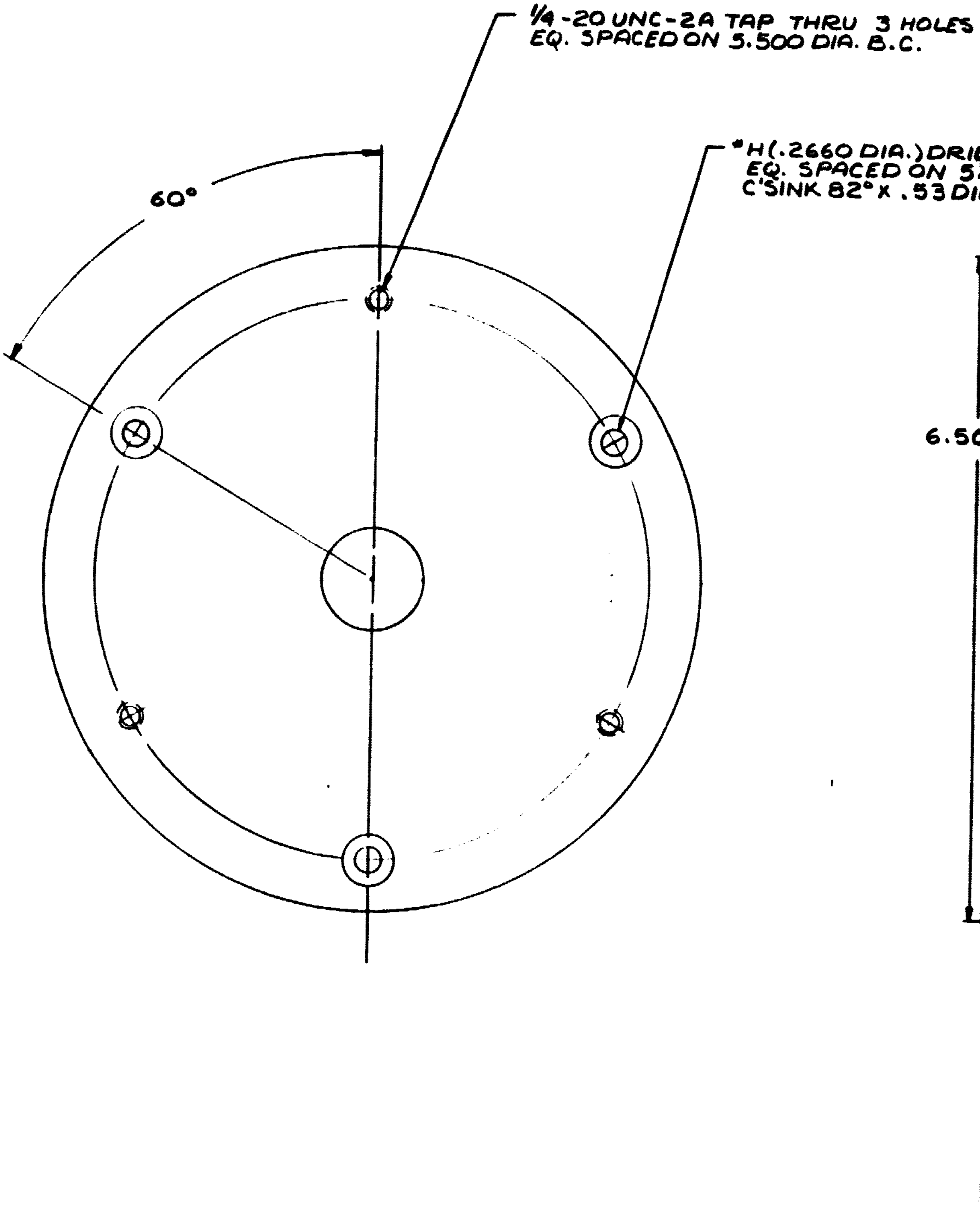
UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, MEMORIAL PARKWAY, HUNTSVILLE, AL	DRAWN BY RVW
DIMENSIONS ARE IN INCHES. TOLERANCE ON: FRACTIONS 1/32; DECIMALS ±.030, ±.010; ANGLES 1°	SOLAR MAX – T/O. FRAM DETAILS	DATE 3-30-84
		APPROVED
MATERIAL 6061 ALUM ALLOY		CONTRACT CC 478
FINAL PROTECTIVE FINISH BLACK ANODIZE; SCALE 1"=10"		DRAWING NUMBER 478107
		SHEET OF



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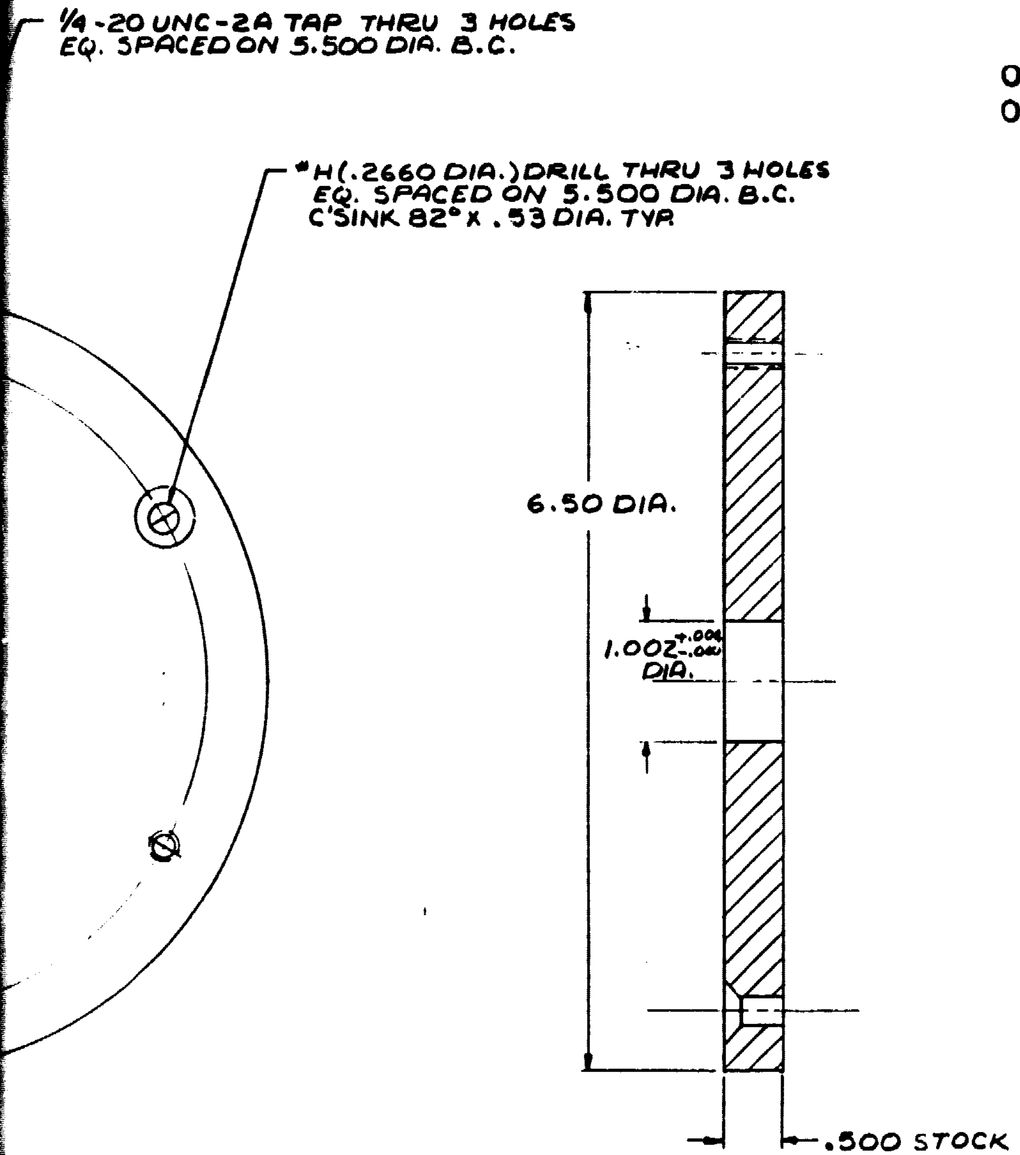

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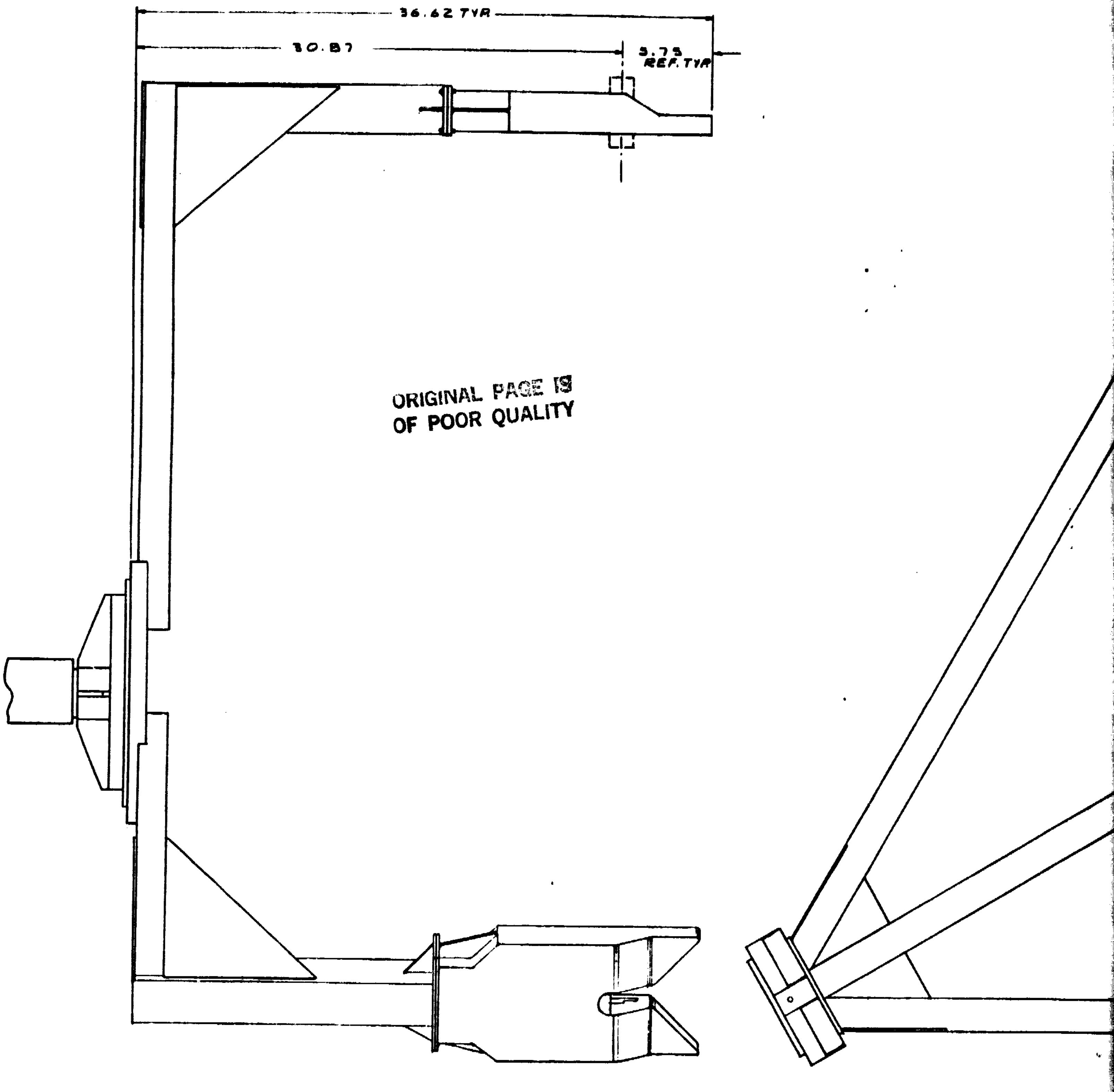
NOTE–
UNLESS OTHERWISE SPECIFIED:

1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .010 R. MAX.
2- TOLERANCES: .XX ±.015
   .XXX±.004
3- MATERIAL: ALUMINUM ALLOY 6061-T6
4- FINAL PROTECTIVE FINISH: ANODIZE, DYE BLACK

ESSEX		
SCALE: 1-1	APPROVED BY:	DRAWN BY LOUGHRAN
DATE: JULY 28, '81		REVISED
MOCKUP ADAPTER PLATE		
T.M.S.		DRAWING NUMBER 810907

APPENDIX C: Drawings of Docking Device



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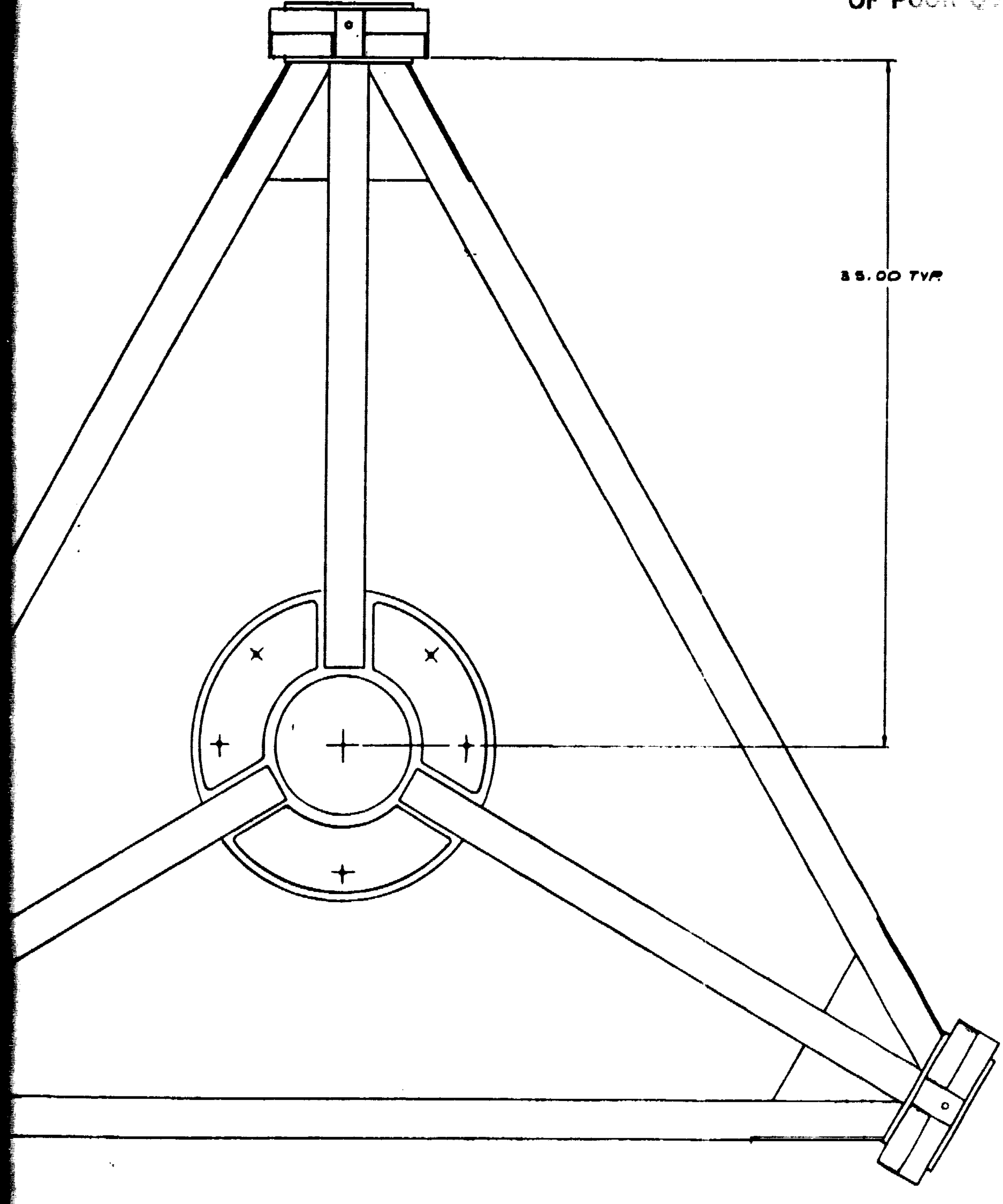

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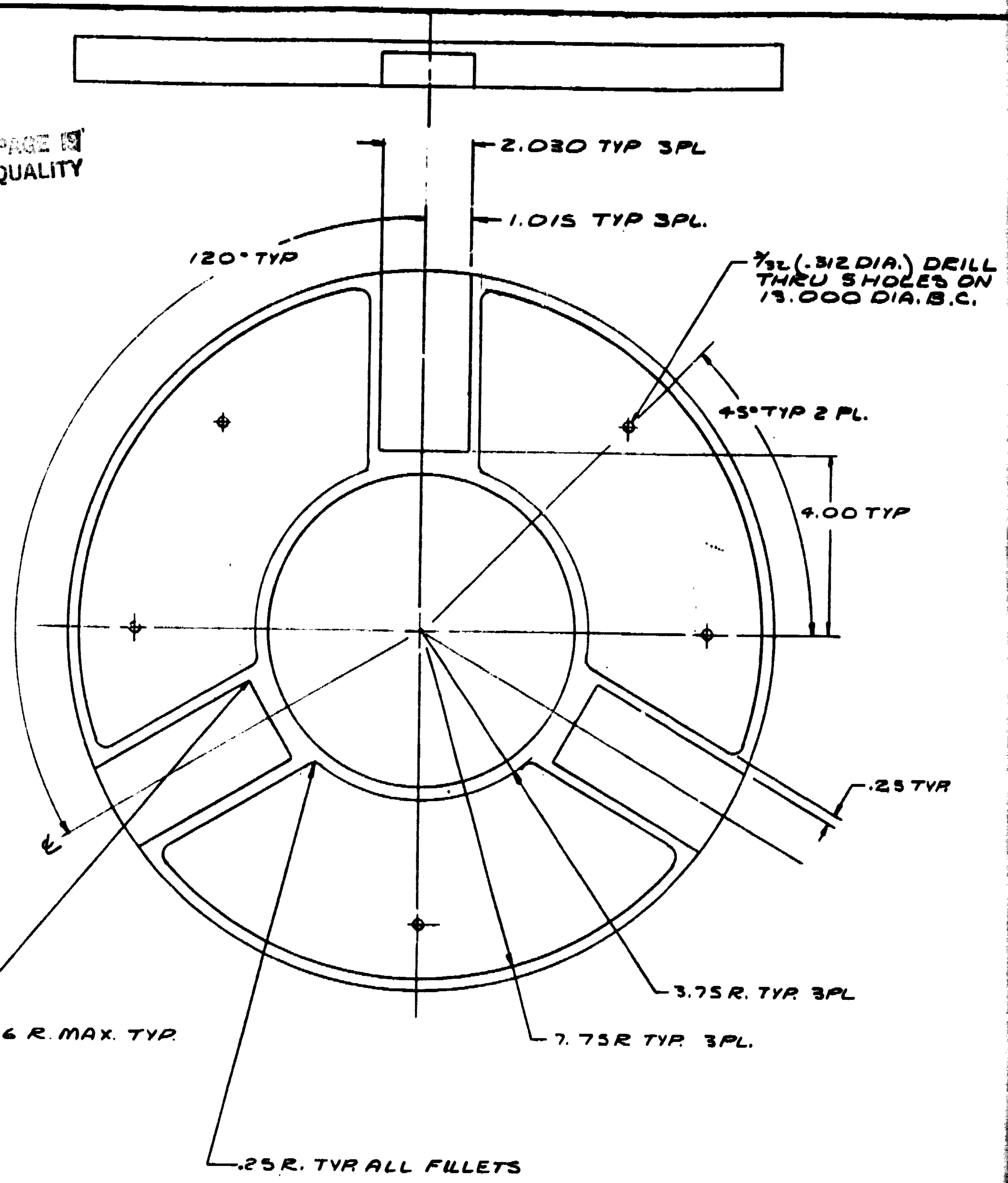
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES	ESSEX HUNTSVILLE FACILITY	DRAWN BY LUGHEAD
MATERIAL ~	CAPTURE DEVICE ASSY	DATE
FINAL PROTECTIVE FINISH ~ / SCALE 1/4		APPROVED
		CONTRACT 00478
		DRAWING NUMBER 478300
		SHEET OF



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TOLERANCE ON
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MATERIAL
AL. ALL...
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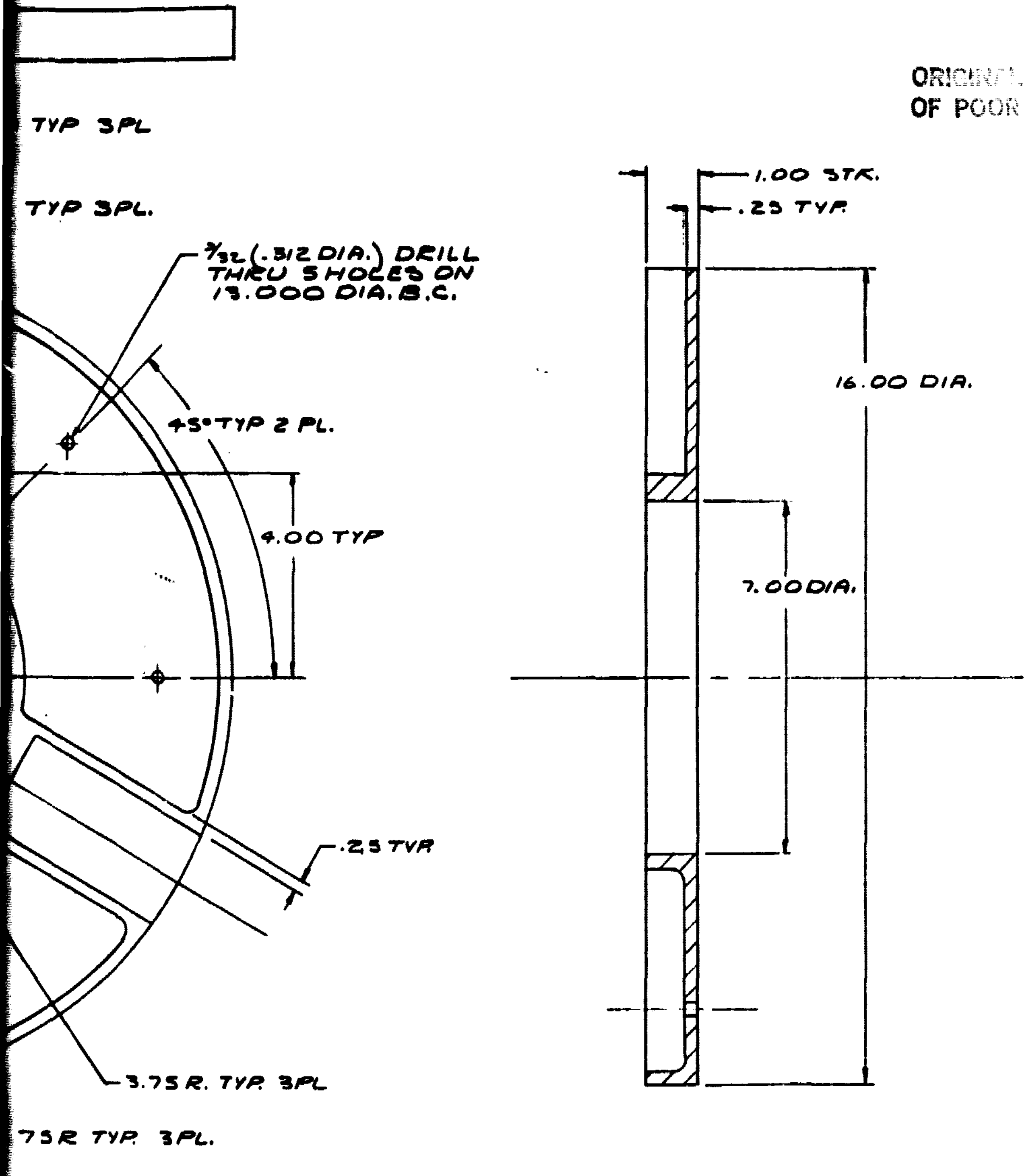

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DIMENSIONS ARE IN INCHES
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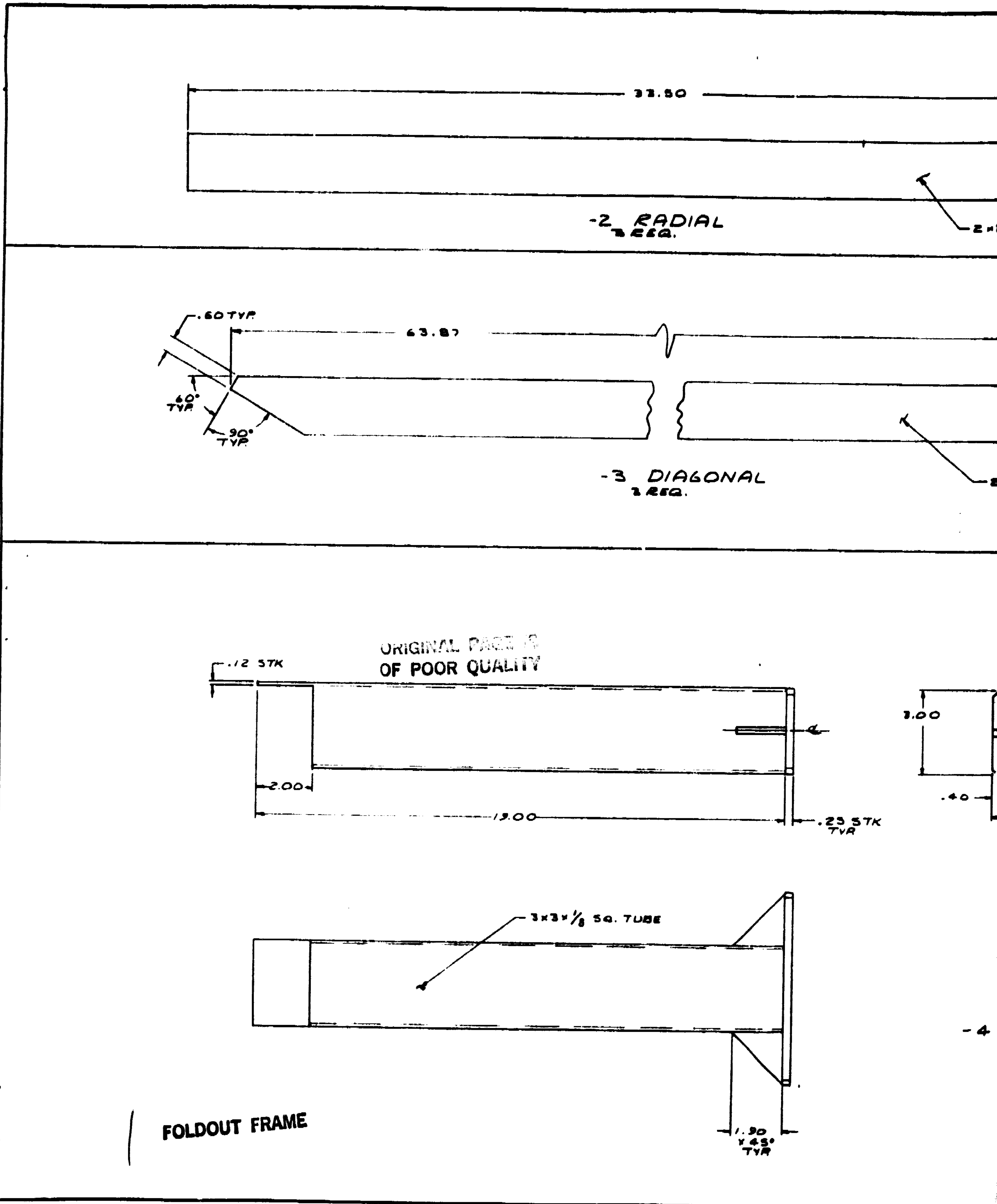
FINAL PROTECTIVE FINISH
NONE
SCALE
1/2

ESSEX
HUNTSVILLE FACILITY
8322 S. MEMORIAL PARKWAY
HUNTSVILLE, AL 35802

CENTER
SUPPORT~
LATCH MOUNT

DRAWN BY
LOUGHEAD
DATE
MAR 26-84
APPROVED
CONTRACT
00478
DRAWING NUMBER
478301
SHEET OF



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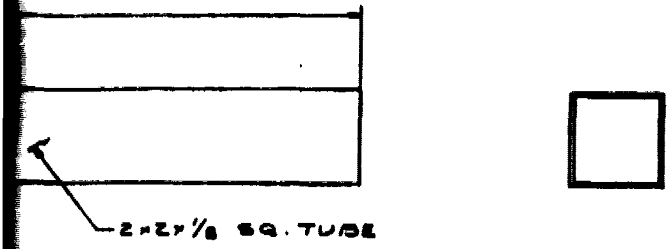

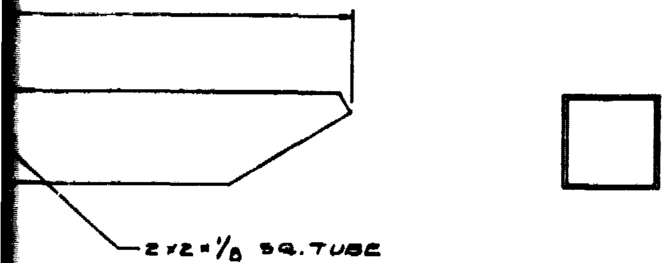

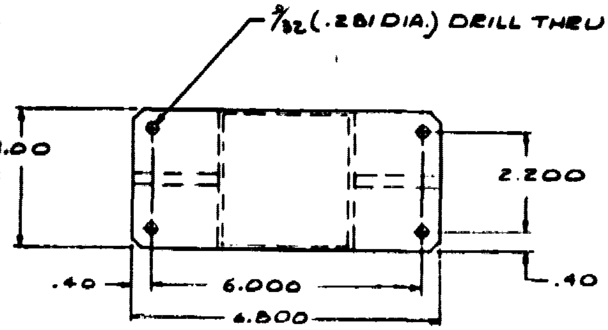

-4 LATCH MOUNT
3 REQ.

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MATERIAL: AL ALLOY	ESSEX	DRAWN BY: LOUAHFAD
SCALE: 1/2	SUPPORT STRUCTURE	CONTRACT: 00178
		DRAWING NUMBER: 478302
		SHEET 2 of 3

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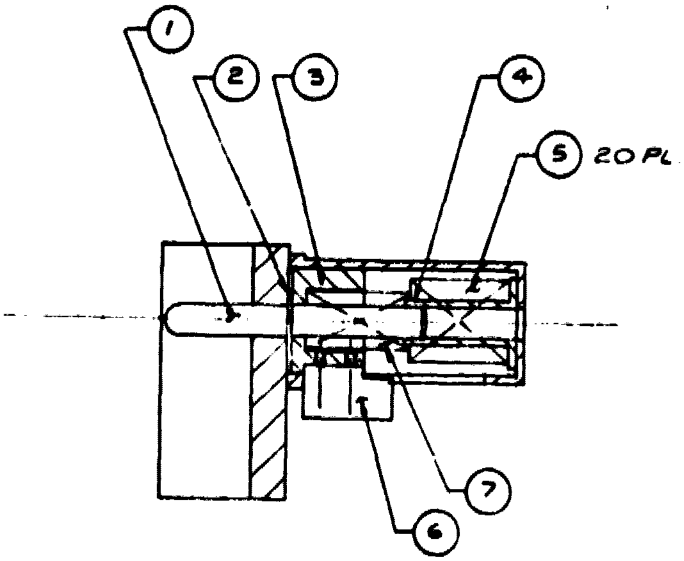

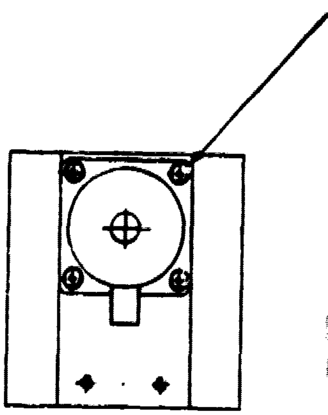

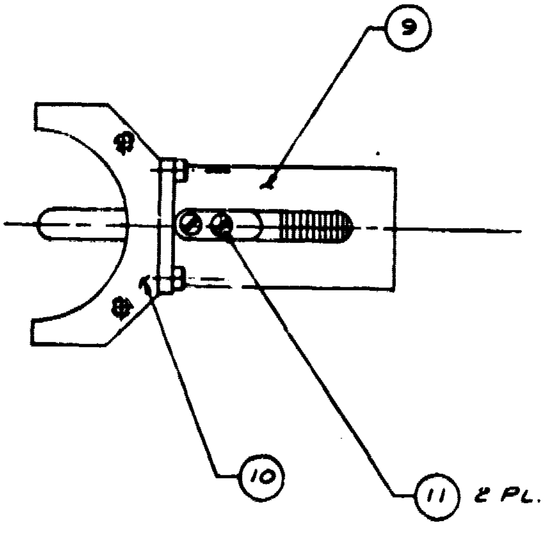

FIND No	QTY
12	
11	2
10	1
9	1
8	4
7	1
6	1
5	20
4	1
3	1
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UNLESS OTHE

DIMENSIONS ARE IN INC
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FINAL PROTECTIVE FIN
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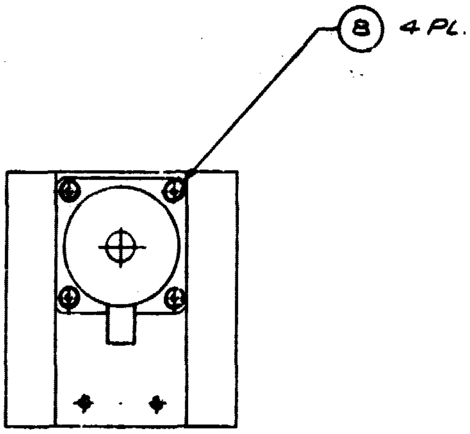

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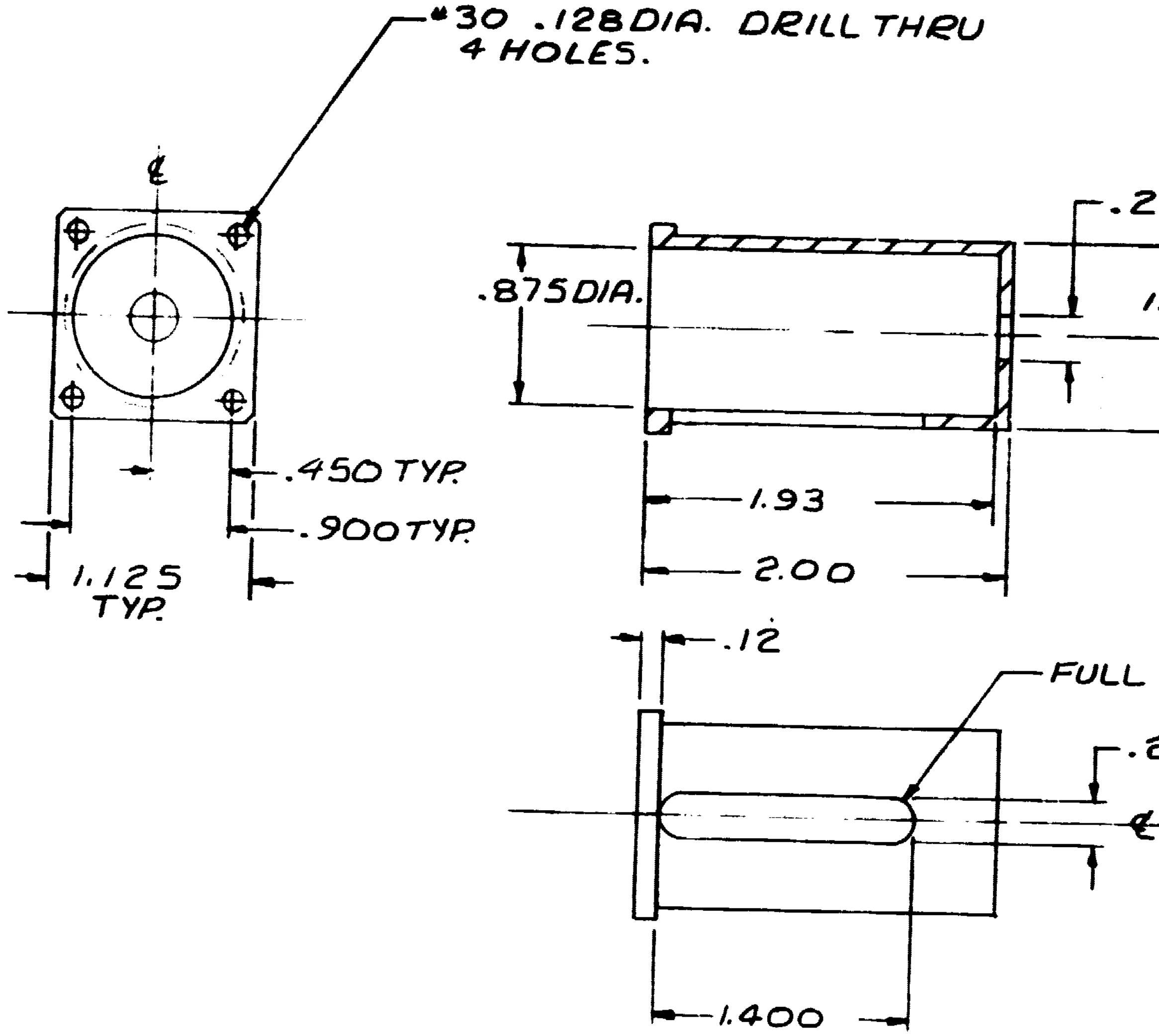
11	2	Y6-S4-A10	4-40NC FLT HD SCREW x.56LG-CRES	BERG
10	1	478005	CENTER SUPPORT	
9	1	478002	HOUSING-SPRING PL.	
8	4	Y9-S4-A6	4-40NC SOC. HD CAP SCR. x.38LG-CRES	BERG
7	1	C0480-032-8805	SPRING-COMP-CRES	ASSOC. SPRING
6	1	478004	CAM	
5	20	BS 18-19.2-0.45	BELLEVILLE SPRING	BEARING ENGINEERS
4	1	478003	SPRING GUIDE	
3	1	478007	PISTON	
2	1	Q1-25	RETAINER RING	BERG
1	1	478006	PLUNGER	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES .XX .XXX	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL 35801	DRAWN BY LOUGHEAD DATE 31 JAN. 84
MATERIAL SEE P.L.	SPRING PLUNGER ASSY	APPROVED CONTRACT 00478
FINAL PROTECTIVE FINISH ~ / SCALE 1-1		DRAWING NUMBER 478001 SHEET OF



UNLESS OTHE

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.5 TO 1.5 MIL TH

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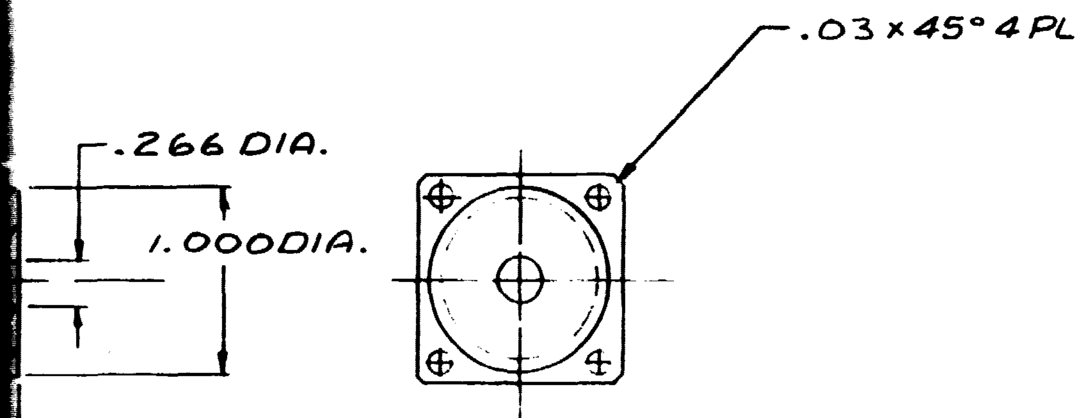

NOTE ~
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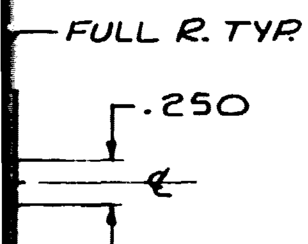
2- ALL FILLETS .03 R.



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[...]IONS ARE IN INCHES
[...]NCE ON
[...]TIONS — DECIMALS: .XX ± .015, .XXX ± .005 — ANGLES: 1°

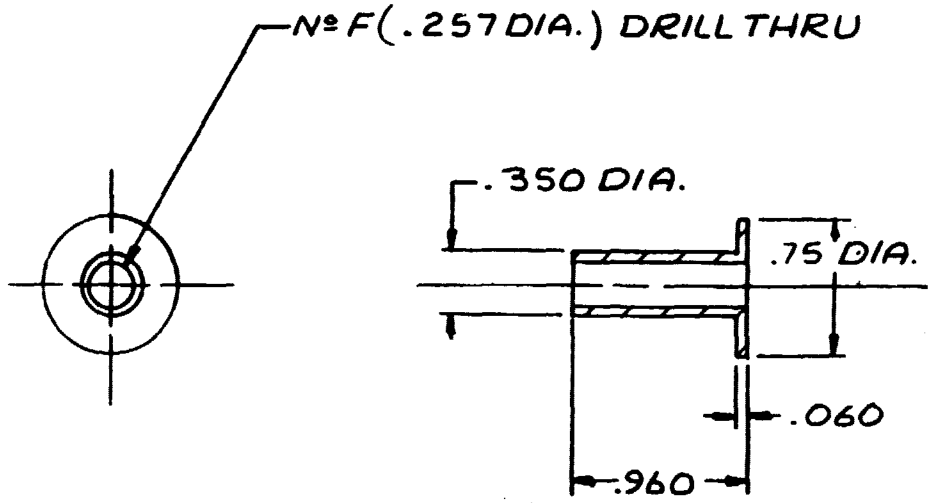
[...]AL: [AL]UM. ALLOY 6061-T6

[P]ROTECTIVE FINISH: [HAR]D ANODIZE [...]1.5 MIL THICK — SCALE: 1-1

ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801

HOUSING ~
SPRING PLUNGER

DRAWN BY	LOUGHEAD
DATE	JAN. 23-'84
APPROVED	[signature]
CONTRACT	00478
DRAWING NUMBER	478002
SHEET	OF



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DIMENSIONS ARE IN INC
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FRACTIONS DE
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FINAL PROTECTIVE FINI
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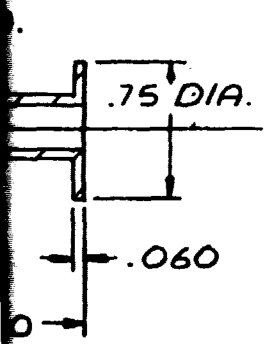

NOTE ~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R.

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UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
DIMENSIONS ARE IN INCHES. TOLERANCE ON FRACTIONS ~ DECIMALS .XX ± .015, .XXX ± .005 ANGLES ~		DATE JAN. 23 -'84
	SPRING GUIDE	APPROVED
MATERIAL ALUM. ALLOY 6061-T6		CONTRACT 00478
		DRAWING NUMBER 478003
FINAL PROTECTIVE FINISH HARD ANODIZE .5 TO 1.5 MIL. THICK — SCALE 1-1		SHEET OF

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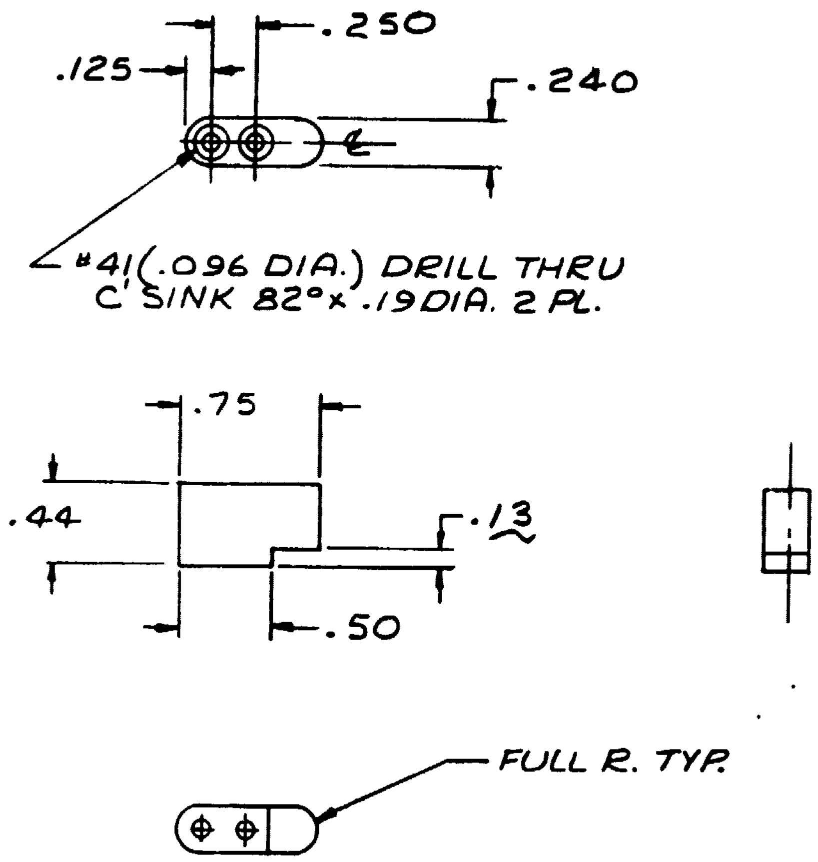

UNLESS OTH

DIMENSIONS ARE IN IN
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MATERIAL
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FINAL PROTECTIVE FIN
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NOTE~
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ALL SHARP EDGES .01-.02R

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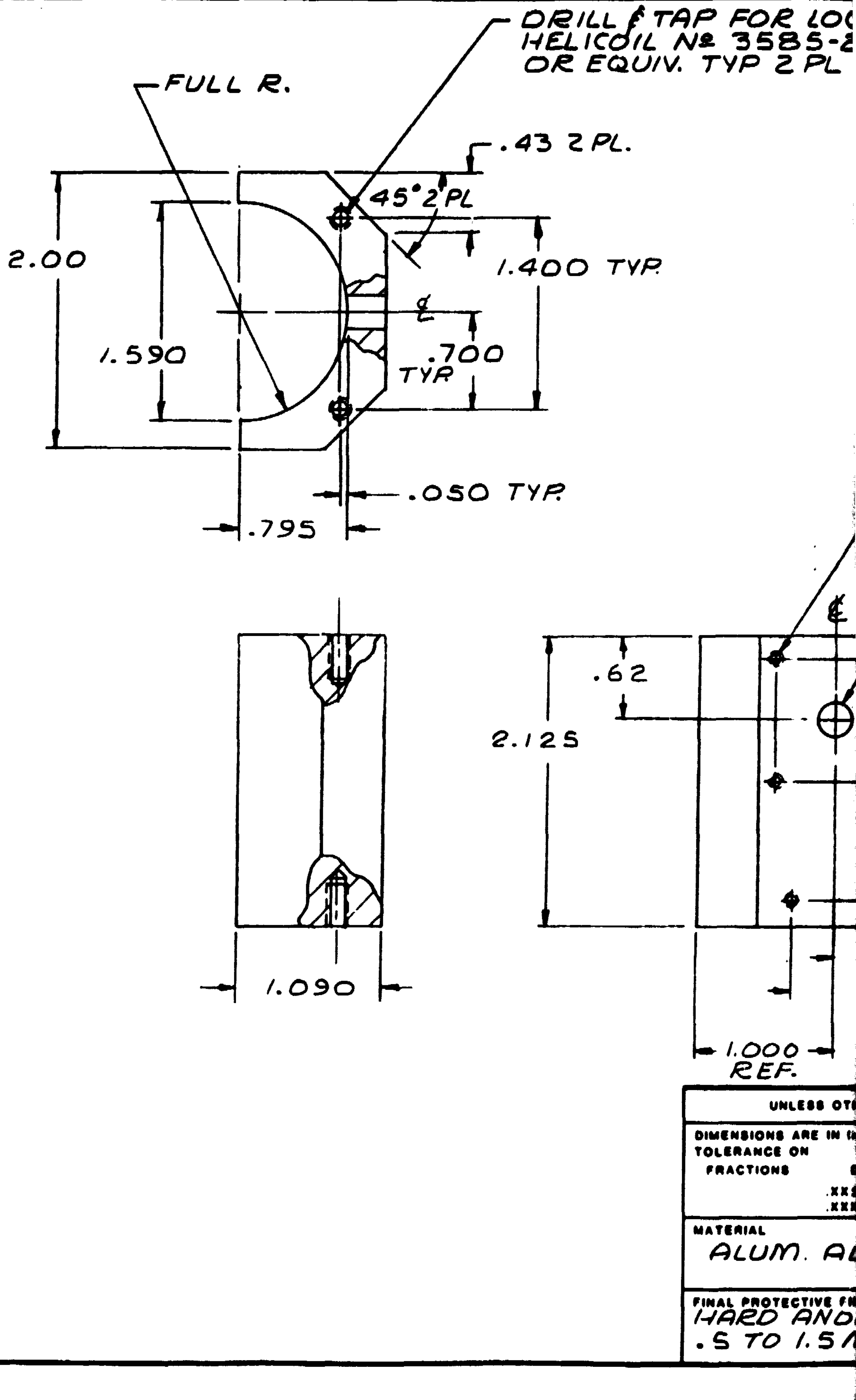
DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ DECIMALS .XX ± .015 .XXX ± .005 ANGLES ~			DATE 23 JAN. 84
			APPROVED
MATERIAL ALUM. ALLOY 6061-T6	CAM		CONTRACT 00478
PROTECTIVE FINISH HARD ANODIZE .5 TO 1.5 MIL THK	SCALE 1-1		DRAWING NUMBER 478004
			SHEET OF



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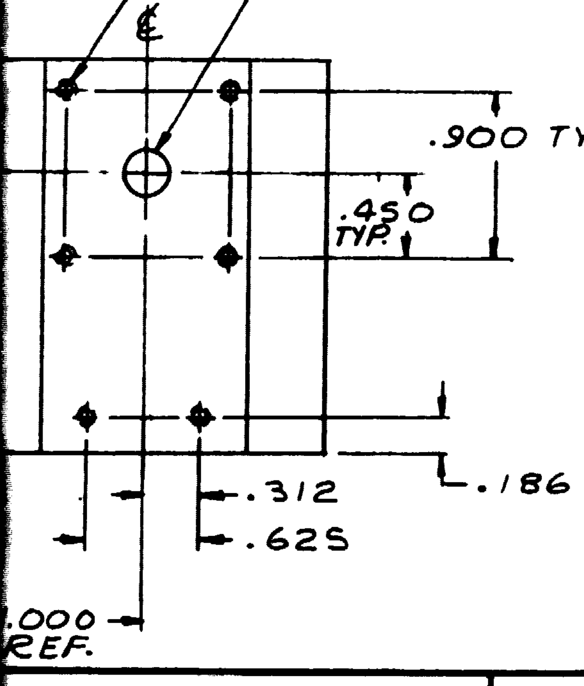
FOR LOCKING THREADED INSERT
3585-2CN-0328 (8-32NC×2D)
P 2 PL BOTH SIDES.

DRILL & TAP FOR LOCKING THREADED INSERT ~ HELICOIL № 3585-04CN-0224 (4-40NC×2D) OR EQUIV. TYP. 6 PL.

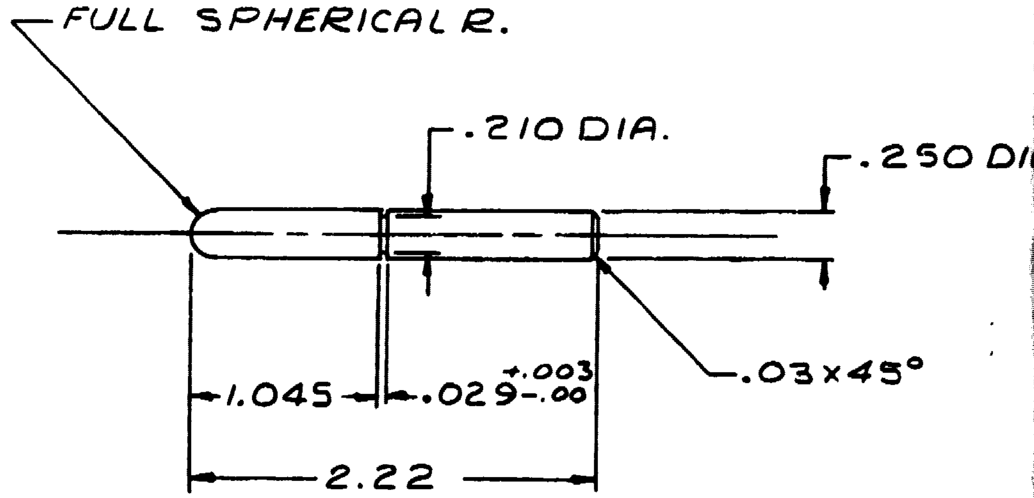
#F (.257 DIA.) DRILL THRU



NOTE ~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R.

UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY: LOUGHEAD
…SIONS ARE IN INCHES …RANCE ON …CTIONS; DECIMALS .XX ± .015, .XXX ± .005; ANGLES ½°	CENTER SUPPORT	DATE: JAN. 24, '84
		APPROVED
…RIAL: …LUM. ALLOY 6061-T6		CONTRACT: 00478
PROTECTIVE FINISH: …RD ANODIZE … TO 1.5 MIL THK		DRAWING NUMBER: 47800S
SCALE: 1-1		SHEET OF

ORIGINAL PAGE IS
OF POOR QUALITY



UNLESS OT
DIMENSIONS ARE IN TOLERANCE ON FRACTIONS .XX .XX
MATERIAL 303 CR
FINAL PROTECTIVE FI ~

FOLDOUT FRAME

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OF POOR QUALITY

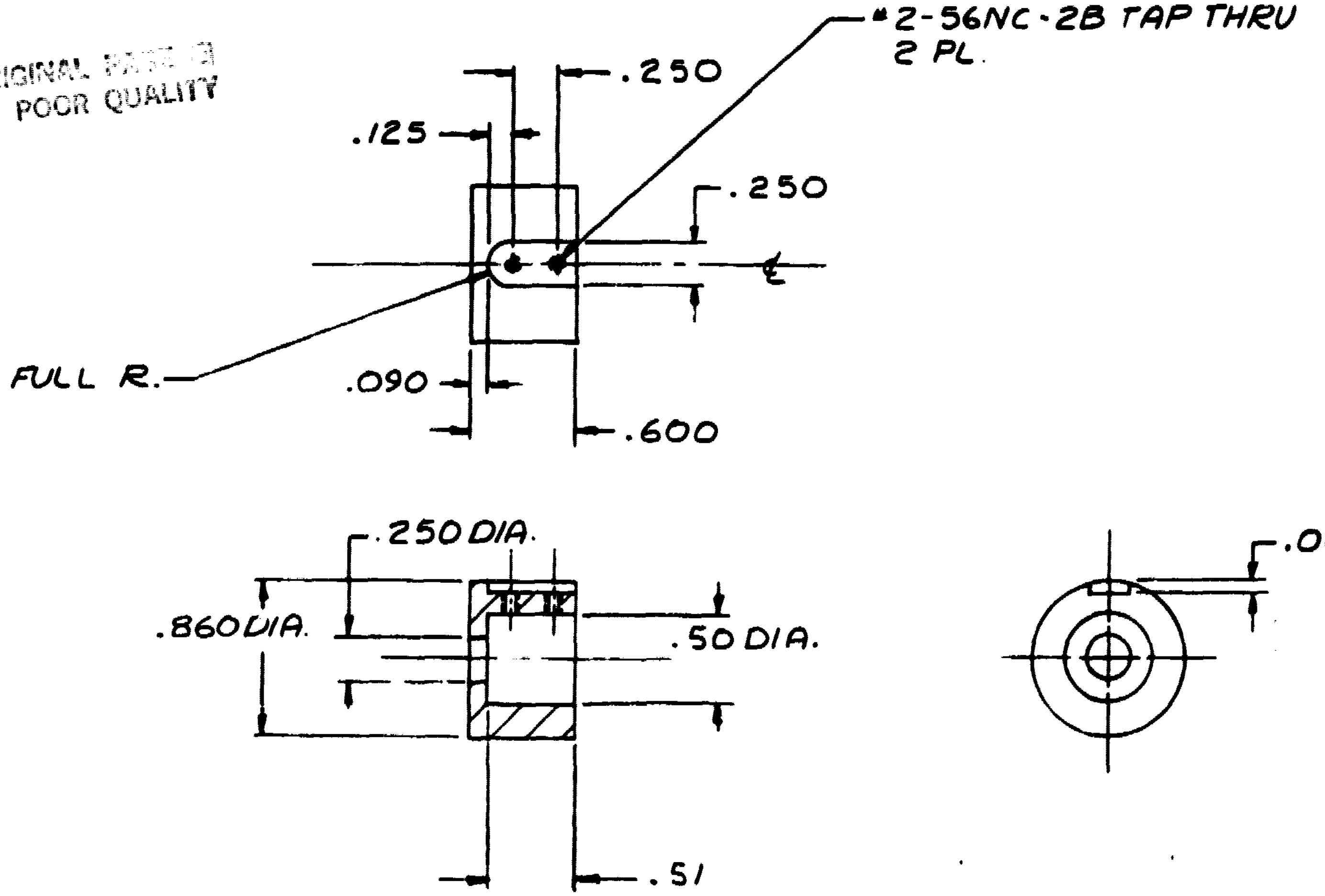
250 DIA. STK.

5°

NOTE ~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01 - .02 R.

2 FOLDOUT FRAME

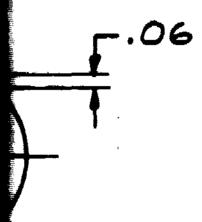
UNLESS OTHERWISE SPECIFIED	ESSEX	HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
IONS ARE IN INCHES ANCE ON TIONS — DECIMALS .XX ± .015 .XXX ± .005 — ANGLES 1°	PLUNGER		DATE JAN 24 - '84
			APPROVED [signature]
AL 03 CRES			CONTRACT 00478
ROTECTIVE FINISH ~ — SCALE 1-1			DRAWING NUMBER 478006
			SHEET OF



UNLESS OTH
DIMENSIONS ARE IN INC TOLERANCE ON FRACTIONS ~ DE .XX± .XXX±
MATERIAL ALUM. ALLO
FINAL PROTECTIVE FIN HARD ANOD .STD 1.5 MIL

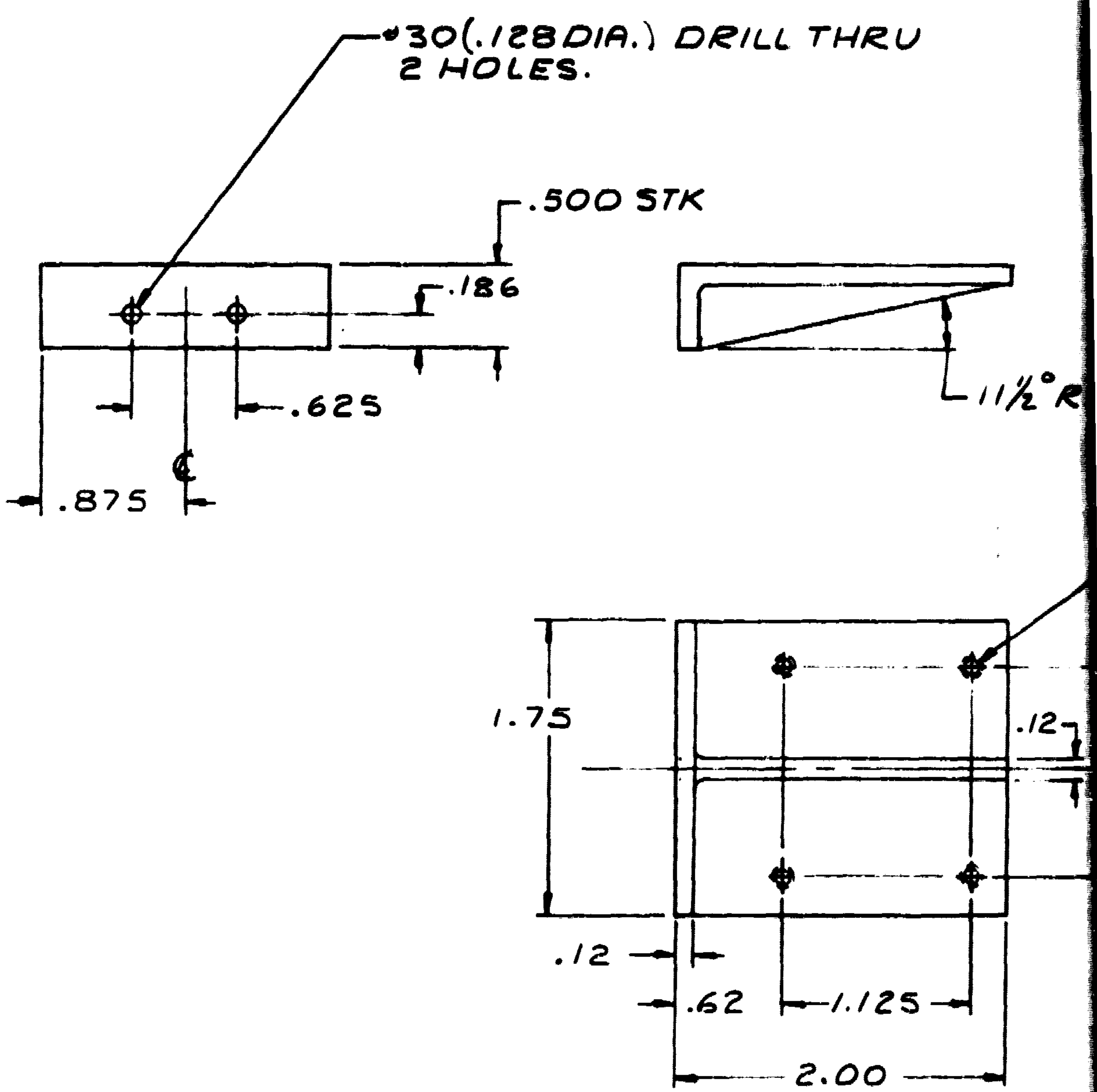
FOLDOUT FRAME

P THRU



NOTE ~
1- REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02R.

UNLESS OTHERWISE SPECIFIED [DIMENS]IONS ARE IN INCHES [TOLER]ANCE ON [DIMENS]IONS DECIMALS .XX ± .015 .XXX ± .005 ANGLES ~	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD DATE JAN. 23 -'84 APPROVED [signature]
[MATERI]AL [AL]UM. ALLOY 6061-T6	PISTON	CONTRACT 00478 DRAWING NUMBER 478007
PROTECTIVE FINISH [HA]RD ANODIZE [T]O 1.5 MIL THK — SCALE 1-1		SHEET OF



UNLESS OTHER
DIMENSIONS ARE IN INCH TOLERANCE ON FRACTIONS DEC XXX - XXXX -
MATERIAL ALUM. ALL
FINAL PROTECTIVE FINISH ALODYNE

FOLDOUT FRAME

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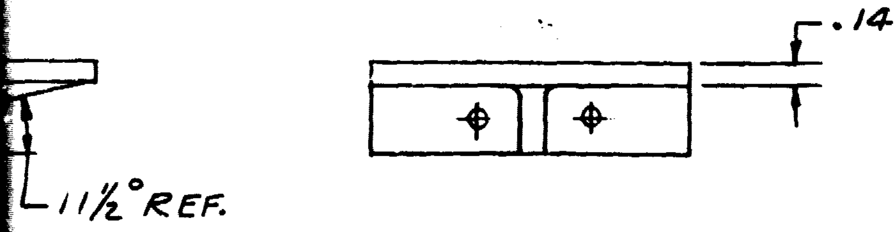
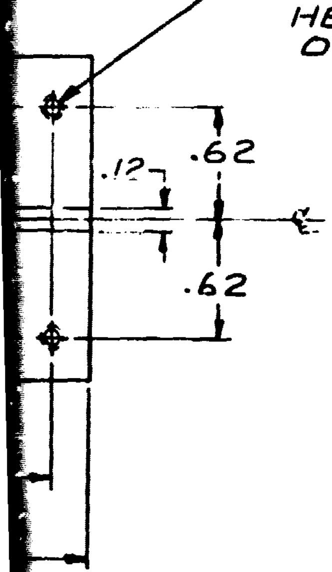
OF POOR QUALITY



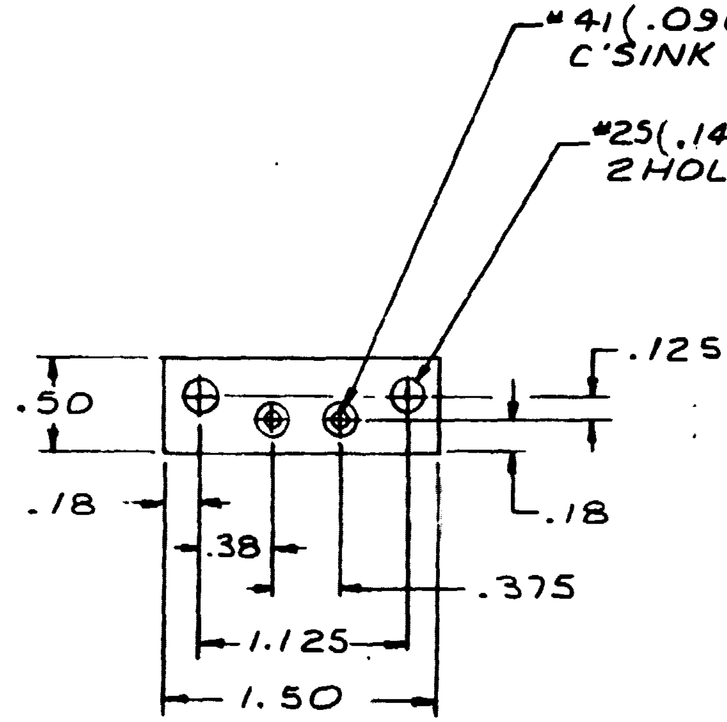
DRILL & TAP FOR LOCKING THREADED INSERT~
HELICOIL Nº 3585-04CN-0168 (4-40NC×1.5D)
OR EQUIV.



NOTE~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02R.
2- ALL FILLETS .06R.

FOLDOUT FRAME 2

UNLESS OTHERWISE SPECIFIED ...S ARE IN INCHES ...E ON ...S DECIMALS .XX± .015 .XXX± .005 ANGLES ~	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801		DRAWN BY LOUGHEAD
	BRACKET		DATE 30 JAN. 84
...M. ALLOY 6061-T6			APPROVED
...ECTIVE FINISH ...DYNE	SCALE 1-1		CONTRACT 00478
			DRAWING NUMBER 478008
			SHEET OF



UNLESS OTHER

DIMENSIONS ARE IN INCH
TOLERANCE ON
FRACTIONS ~
DEC
.XX ±
.XXX ±

MATERIAL
ALUM. ALLO

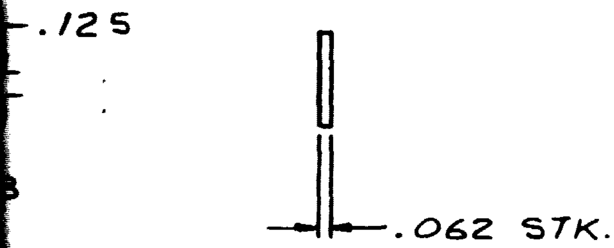
FINAL PROTECTIVE FINISH
ALODYNE

FOLDOUT FRAME

ORIGINAL PAGE IS OF POOR QUALITY

1(.096 DIA.) DRILL THRU
'SINK 82°x.18 DIA.-2 PL.

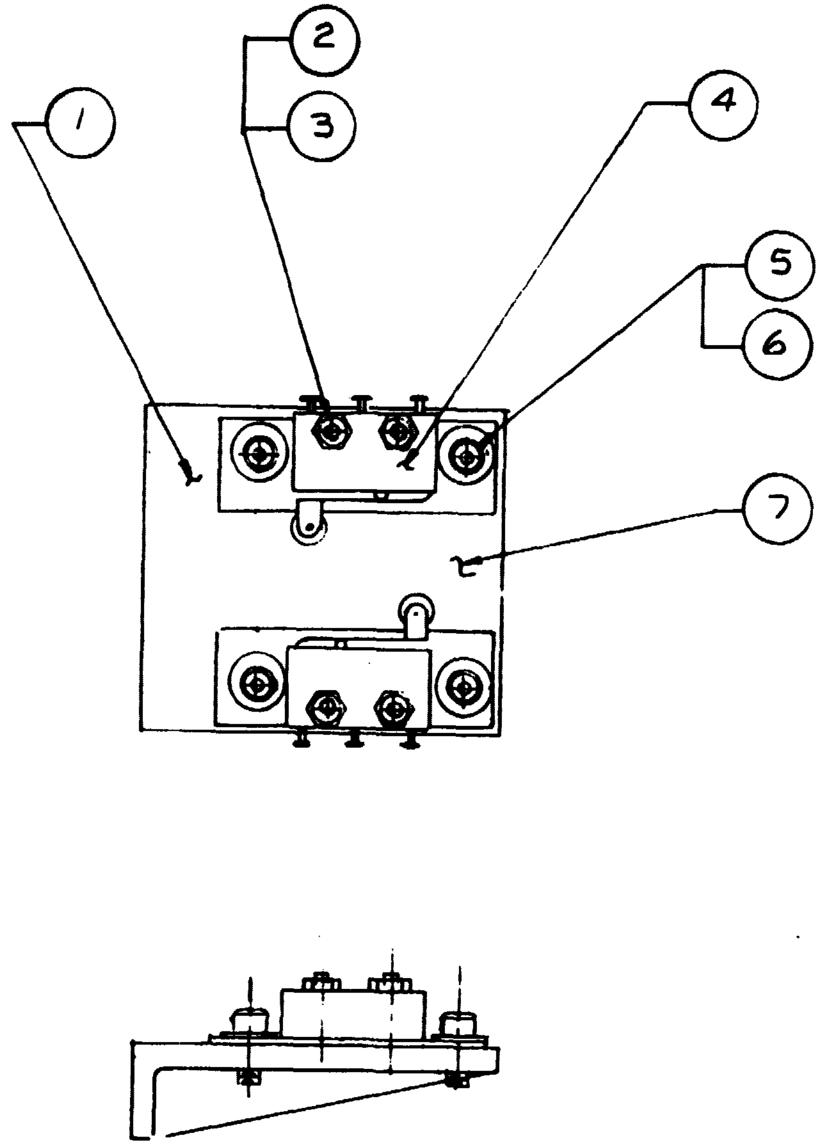
#25(.149 DIA.) DRILL THRU
2 HOLES.



NOTE~
1- REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02 R.

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED ...ONS ARE IN INCHES ...NCE ON ...ONS DECIMALS .XX ±.015 .XXX ±.005 ANGLES ~	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD DATE JAN 30-'84 APPROVED
...M. ALLOY 6061-T6	SWITCH MOUNTING PLATE	CONTRACT 00478 DRAWING NUMBER 478009
...OTECTIVE FINISH ...ODYNE SCALE 1-1		SHEET OF



FIND Nº	QTY
7	2
6	4
5	4
4	2
3	4
2	4
1	1

UNLESS OTHE

DIMENSIONS ARE IN INC
TOLERANCE ON
FRACTIONS DEC
XX ±
XXX ±

MATERIAL
SEE A

FINAL PROTECTIVE FINIS
~

FOLDOUT FRAME

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OF POOR QUALITY

2 FOLDOUT FRAME

FIND Nº	QTY	CAT. Nº / DWG Nº	DESCRIPTION	NOTE
7	2	478009	SWITCH MOUNTING PLATE	
6	4	Y9-S4-A4	SOC. HD CAP SCREW 4-40NC × .25 LG.	BERG
5	4	Z4-4	FLAT WASHER-#4	BERG
4	2	111SM2-T	SWITCH	MICRO SWITCH
3	4	Y5-2	NUT 2-56NC	BERG
2	4	Y6-S2-A6	SCREW F.H. 2-56 × .38 LG	BERG
1	1	478008	BRACKET	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS DECIMALS ANGLES
XX ±
XXX ±

MATERIAL
SEE P.L.

FINAL PROTECTIVE FINISH
~

SCALE
1-1

ESSEX
HUNTSVILLE FACILITY
3322 S. MEMORIAL PARKWAY
HUNTSVILLE, AL 35801

SWITCH ASSY.

DRAWN BY LOUGHEAD
DATE JAN. 30-'84
APPROVED
CONTRACT 00478
DRAWING NUMBER 478010
SHEET OF

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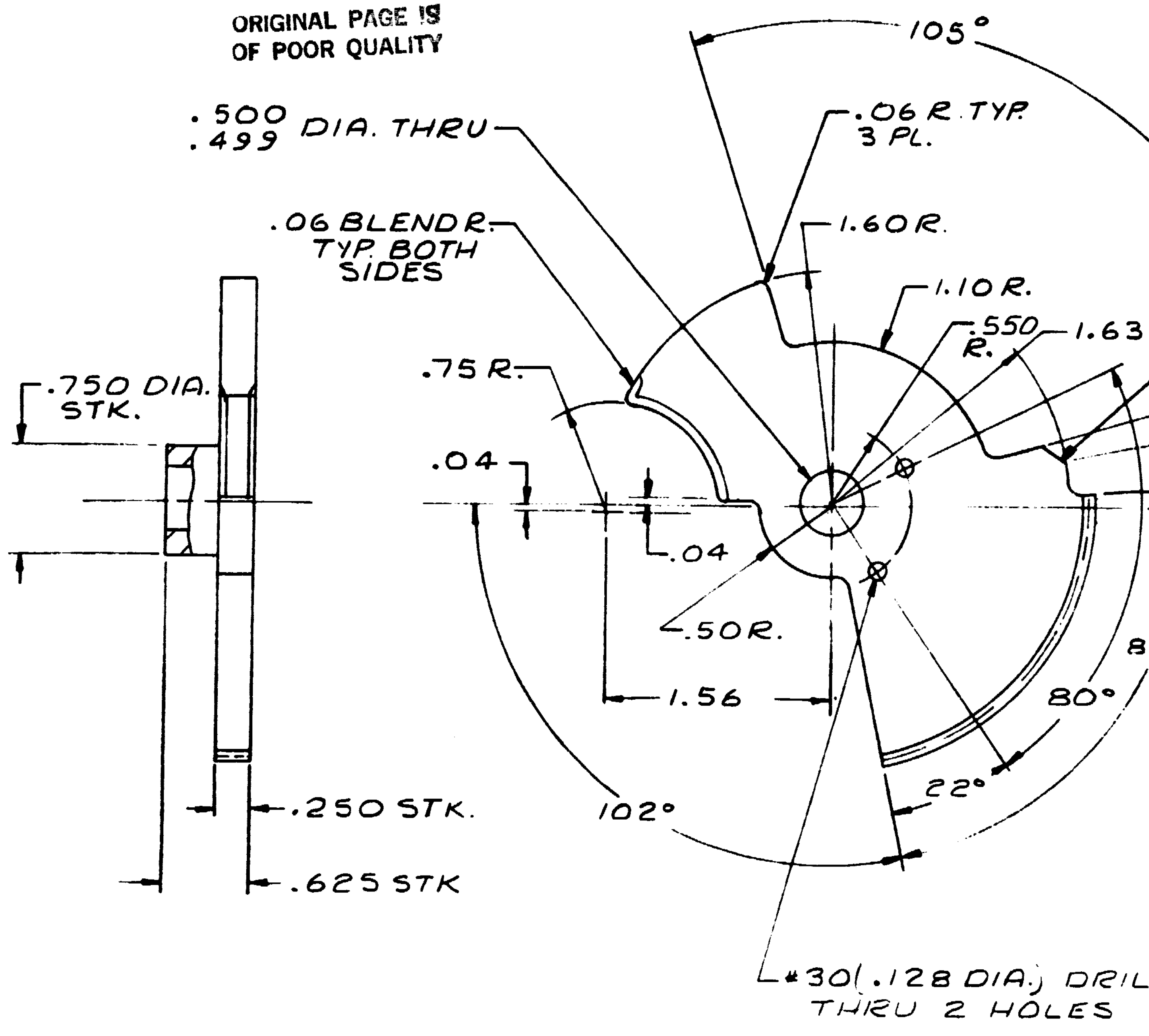


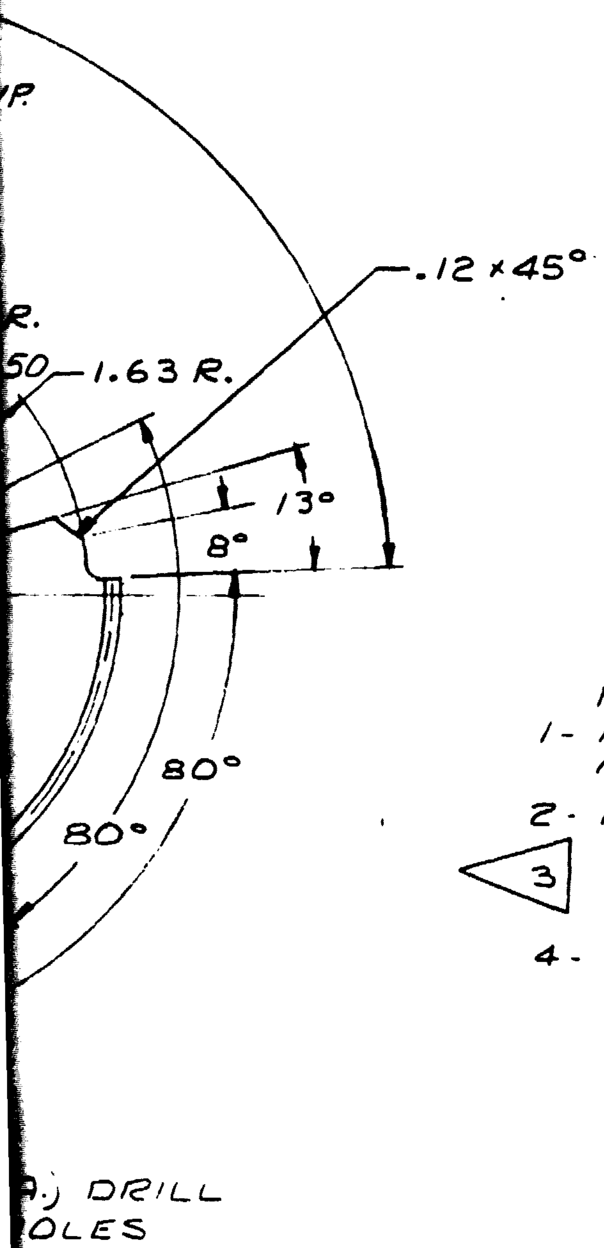
UNLESS OTH

DIMENSIONS ARE IN INC
TOLERANCE ON
FRACTIONS DE
.XX ±
.XXX ±

MATERIAL 3

FINAL PROTECTIVE FIN

FOLDOUT FRAME



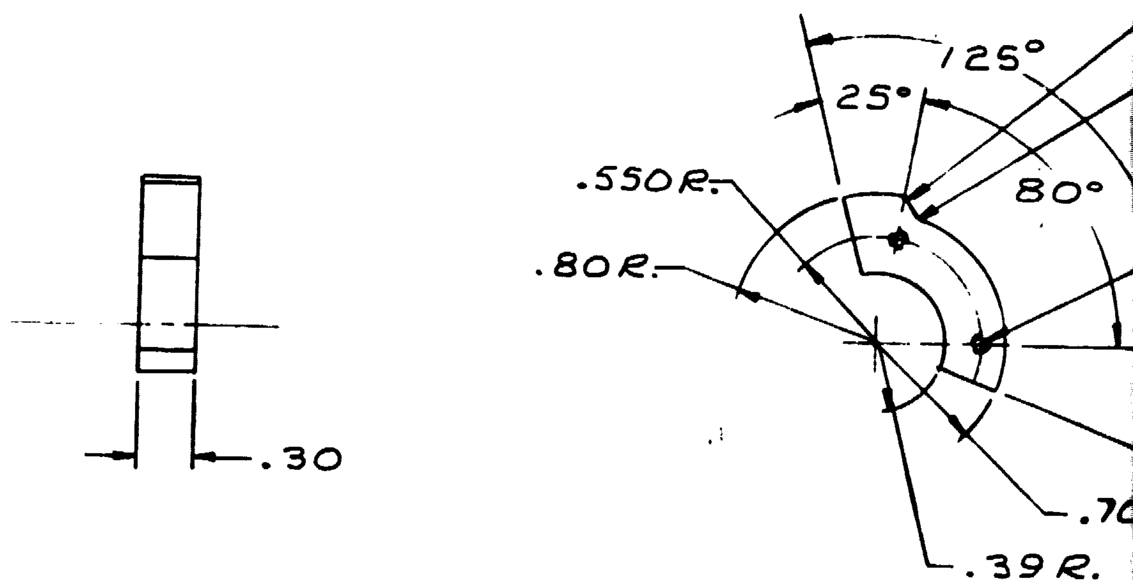
NOTE~

1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R.
2- ALL FILLETS .09 R.
3 MAKE FROM BERG GEAR № P20S33-70
4- PN 478011-1 SHOWN
478011-2 OPPOSITE

FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED …SIONS ARE IN INCHES …ANCE ON …TIONS DECIMALS .XX ± .015 .XXX ± .005 ANGLES ½°	ESSEX	HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
…AL 3 303 CRES	CAM-LATCH		DATE FEB 3-'84
			APPROVED
			CONTRACT 00478
PROTECTIVE FINISH			DRAWING NUMBER 478011
SCALE 1-1			SHEET OF

ORIGINAL PAGE IS
OF POOR QUALITY



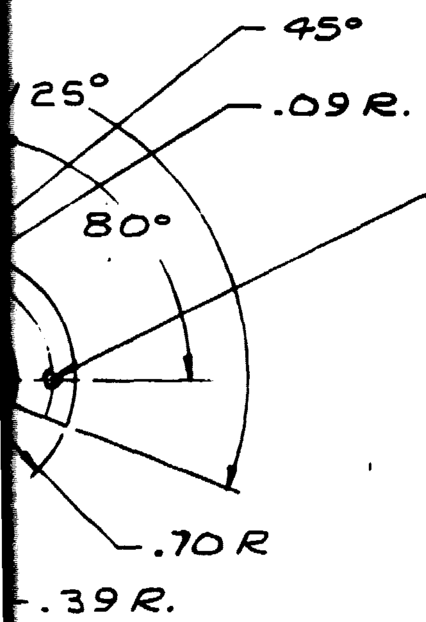
UNLESS OTHER

DIMENSIONS ARE IN INCH
TOLERANCE ON
FRACTIONS DECI
XX ±
XXX ±

MATERIAL
ALUM. ALL

FINAL PROTECTIVE FINISH
CLEAR ANO

FOLDOUT FRAME

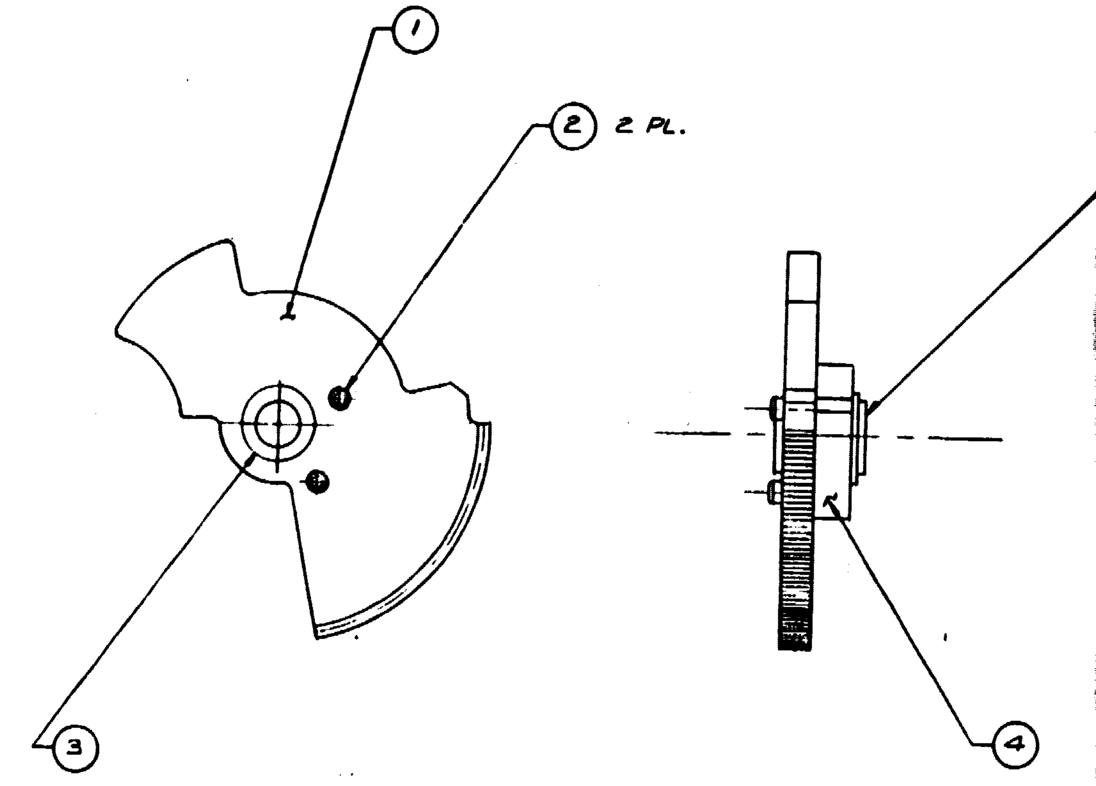


DRILL & TAP THRU FOR LOCKING THREADED INSERT ~ HELICOIL № 3585-04CN-0280 (№ 4-40NC × 2.5D.) OR EQUIV.

NOTE ~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R.

FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED ...IONS ARE IN INCHES ...ANCE ON ...TIONS DECIMALS .XX ± .015 .XXX ± .005 ANGLES ½°	ESSEX	HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
...AL ...UM. ALLOY-6061-T6	CAM ~ SWITCH		DATE FEB 3-81
...ROTECTIVE FINISH ...AR ANODIZE	SCALE 1-1		APPROVED
			CONTRACT 00478
			DRAWING NUMBER 478012
			SHEET OF



4	1
3	2
2	2
1	1
FIND Nº	QTY.

UNLESS

DIMENSIONS ARE IN
TOLERANCE ON
FRACTIONS
~

MATERIAL
SEE

FINAL PROTECTIVE
~

FOLDOUT FRAME

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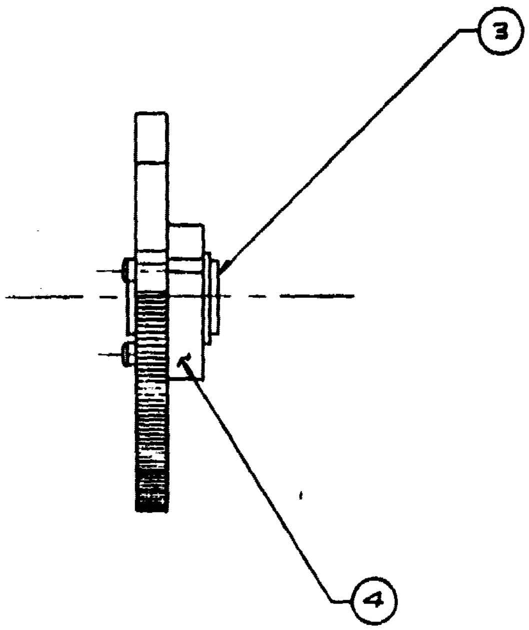
2 PL.



-1 SHOWN
-2 OPPOSITE

2 FOLDOUT FRAME

FIND Nº	QTY.	CAT. Nº - DWG. Nº	DESCRIPTION	NOTE
4	1	478012	CAM-SWITCH	
3	2	B7-42	BUSHING	BERG
2	2	Y9-54-AB	SCREW-SOC. HD CAP 4-40 x 1/2 LG	BERG
1	1	478011	CAM-LATCH	

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ~ DECIMALS .XX ~ .XXX ~ ANGLES ~

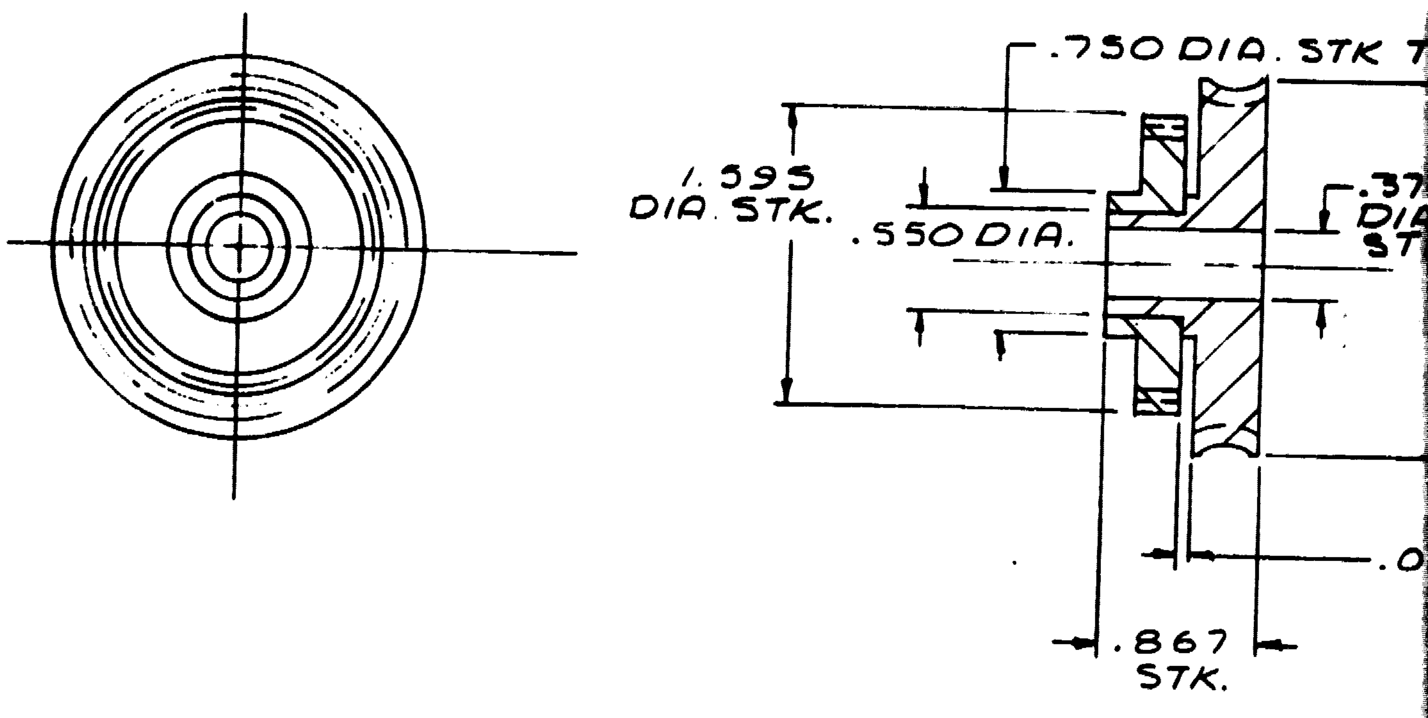
MATERIAL
SEE P.L.

FINAL PROTECTIVE FINISH ~
SCALE 1-1

ESSEX
HUNTSVILLE FACILITY
3322 S. MEMORIAL PARKWAY
HUNTSVILLE AL 35801

CAM ASSY

DRAWN BY LOUGHEAD
DATE 8 FEB '84
APPROVED
CONTRACT 00478
DRAWING NUMBER 478013
SHEET OF



FIND Nº	QTY	
2	1	
1	1	F

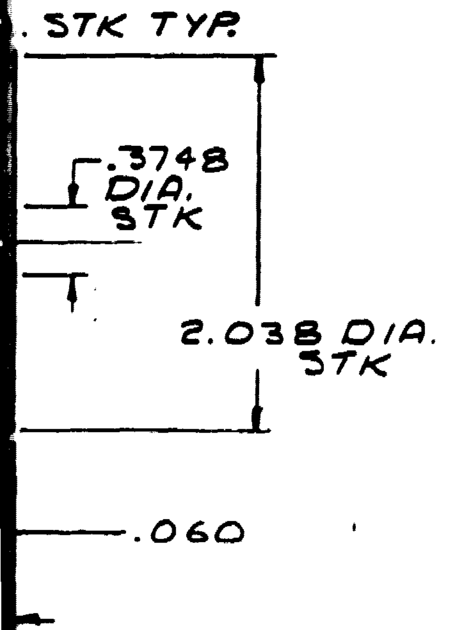
UNLESS OTHER

DIMENSIONS ARE IN INCH
TOLERANCE ON
FRACTIONS DEC
XX± .
XXX± .

MATERIAL
SEE P

FINAL PROTECTIVE FINISH
NONE

FOLDOUT FRAME



1 - PRESS FIT (1) ON (2) (.0010 TO .0015 INTERFERENCE).

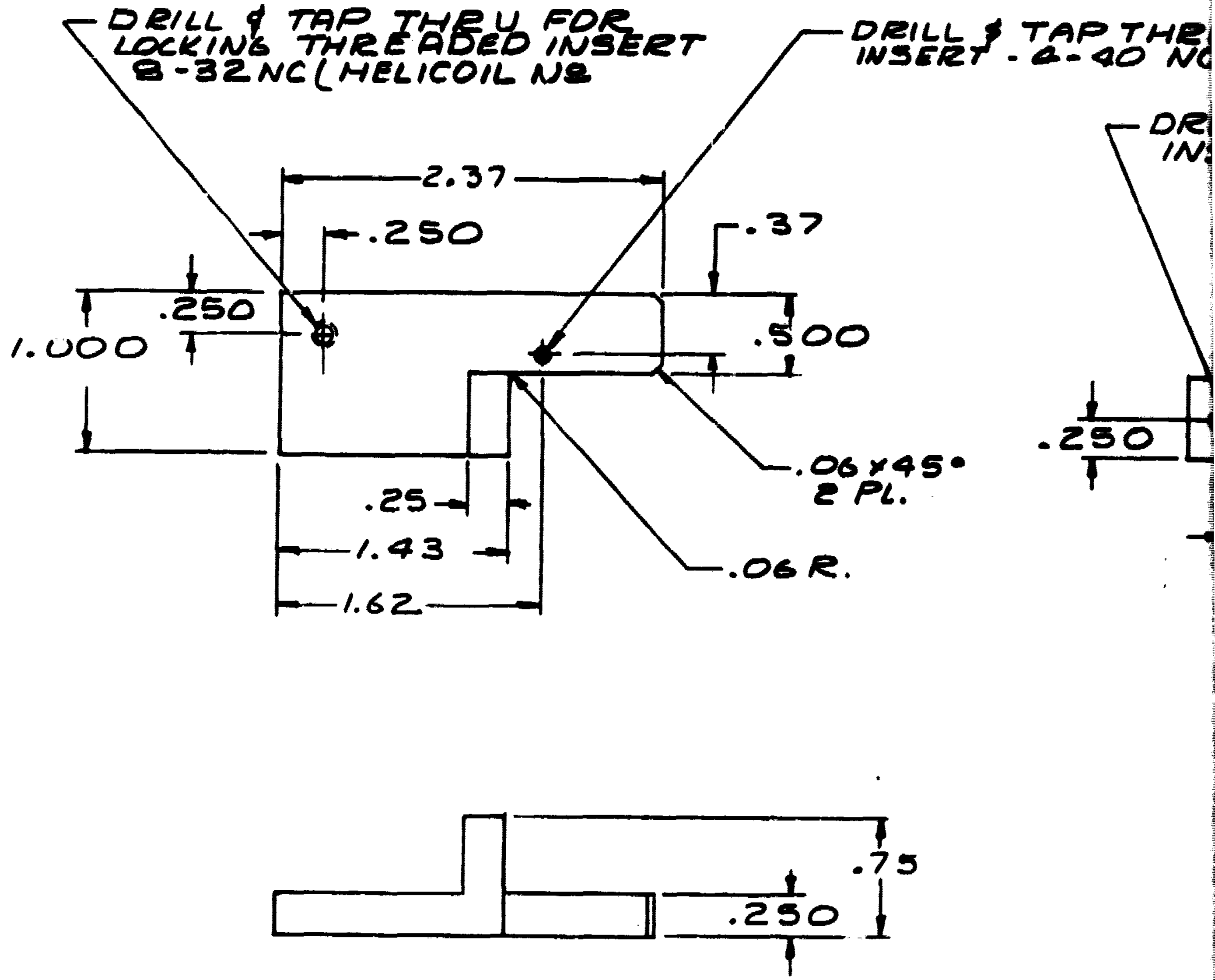
2. REMOVE ALL BURRS & BREAK ALL SHARP EDGES.

	QTY	CAT NO	DESCRIPTION	NOTE
	1	W16B35-S30	WHEEL (WORM)	BER6
	1	P20S33-30	GEAR	BER6

PARTS LIST

UNLESS OTHERWISE SPECIFIED ...ONS ARE IN INCHES ...CE ON ...ONS DECIMALS .XX± .015 .XXX± .005 ANGLES ~	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHRAN
SEE P.L.	GEAR ASSY	DATE 4-11-84
...OTECTIVE FINISH NONE	SCALE 1-1	APPROVED
		CONTRACT 00478
		DRAWING NUMBER 478016
		SHEET OF

2 FOLDOUT FRAME



-1 SHOWN
-2 OPPOSITE

UNLESS OTH

DIMENSIONS ARE IN IN
TOLERANCE ON
FRACTIONS
~

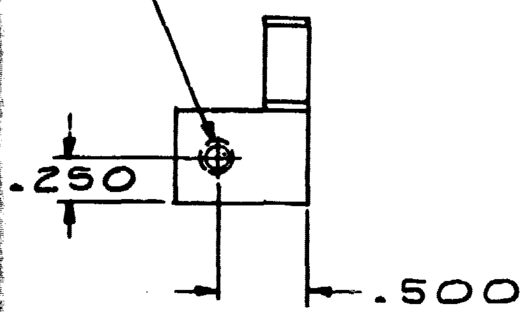
MATERIAL
ALUM A

FINAL PROTECTIVE FIN
HARD ANO

/ FOLDOUT FRAME

TAP THRU FOR LOCKING THREADED
4-40 NC (HELICOIL No

DRILL & TAP THRU FOR LOCKING THREADED
INSERT ~ 10-32 NF (HELICOIL No



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NOTE ~

1- REMOVE ALL BURRS & BREAK ALL
SHARP EDGES .01-.02 R.

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ DECIMALS .XX ± .015 .XXX ± .005 ANGLES ~	ESSEX HUNTSVILLE FACILITY .22 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
		DATE 2 APRIL 84
MATERIAL ALUM ALLOY 6061-T6	SLIDER	APPROVED
		CONTRACT 00478
FINAL PROTECTIVE FINISH HARD ANODIZE	SCALE 1-1	DRAWING NUMBER 478017
		SHEET OF

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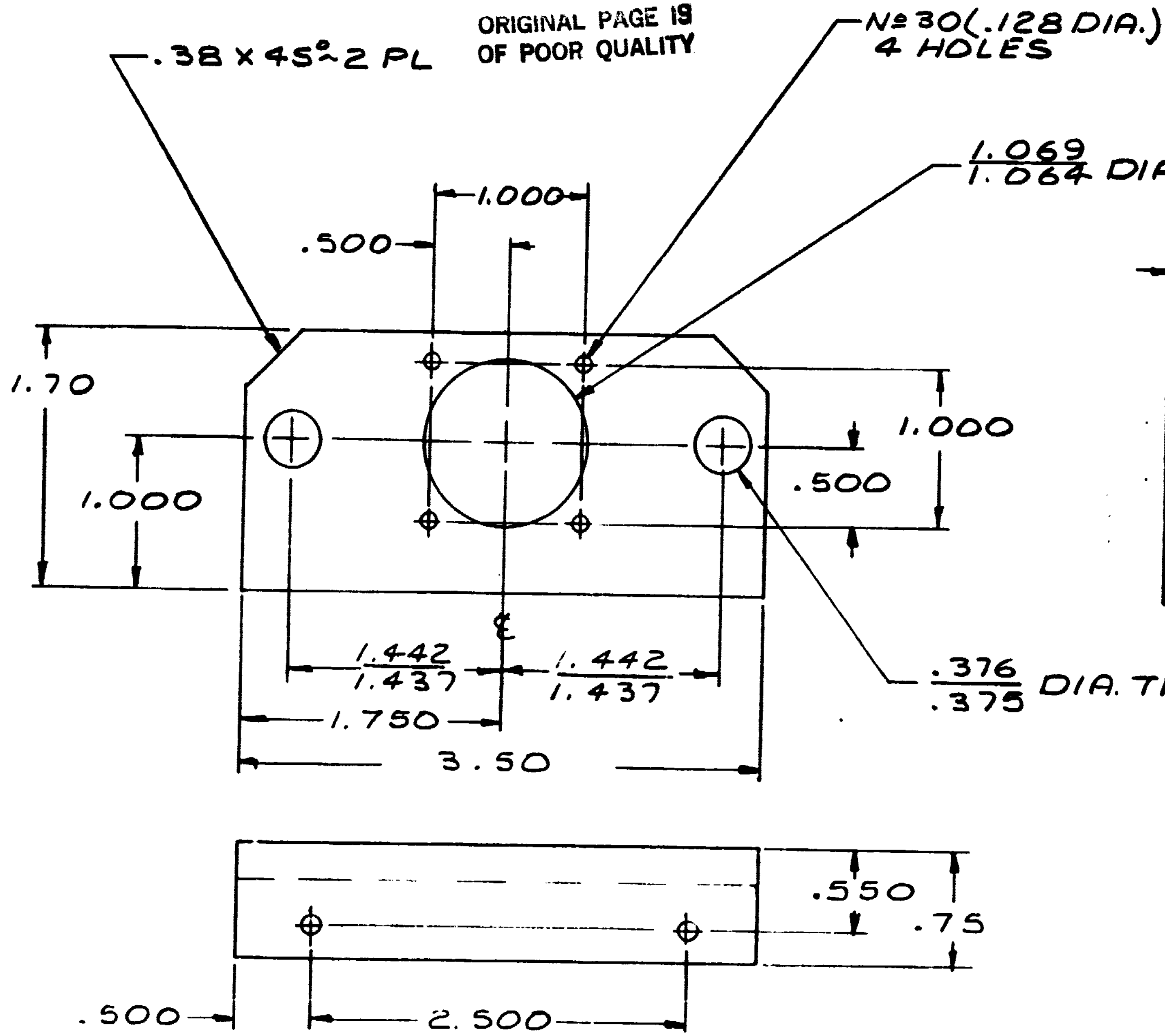

UNLESS OTHE

DIMENSIONS ARE IN INC
TOLERANCE ON
FRACTIONS DE
.XX ±
.XXX ±

MATERIAL
ALUM A

FINAL PROTECTIVE FINIS
CLEAR AN

FOLDOUT FRAME

28 DIA.) DRILL THRU
ES

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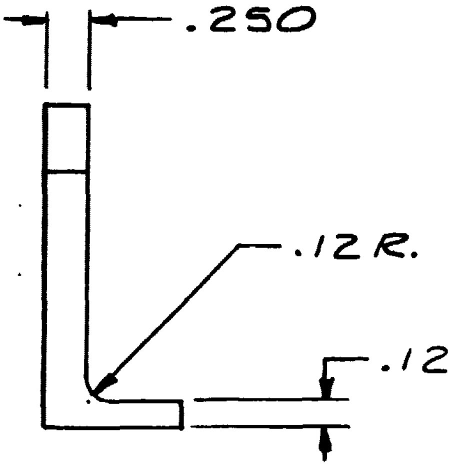
$\frac{.069}{.064}$ DIA. THRU



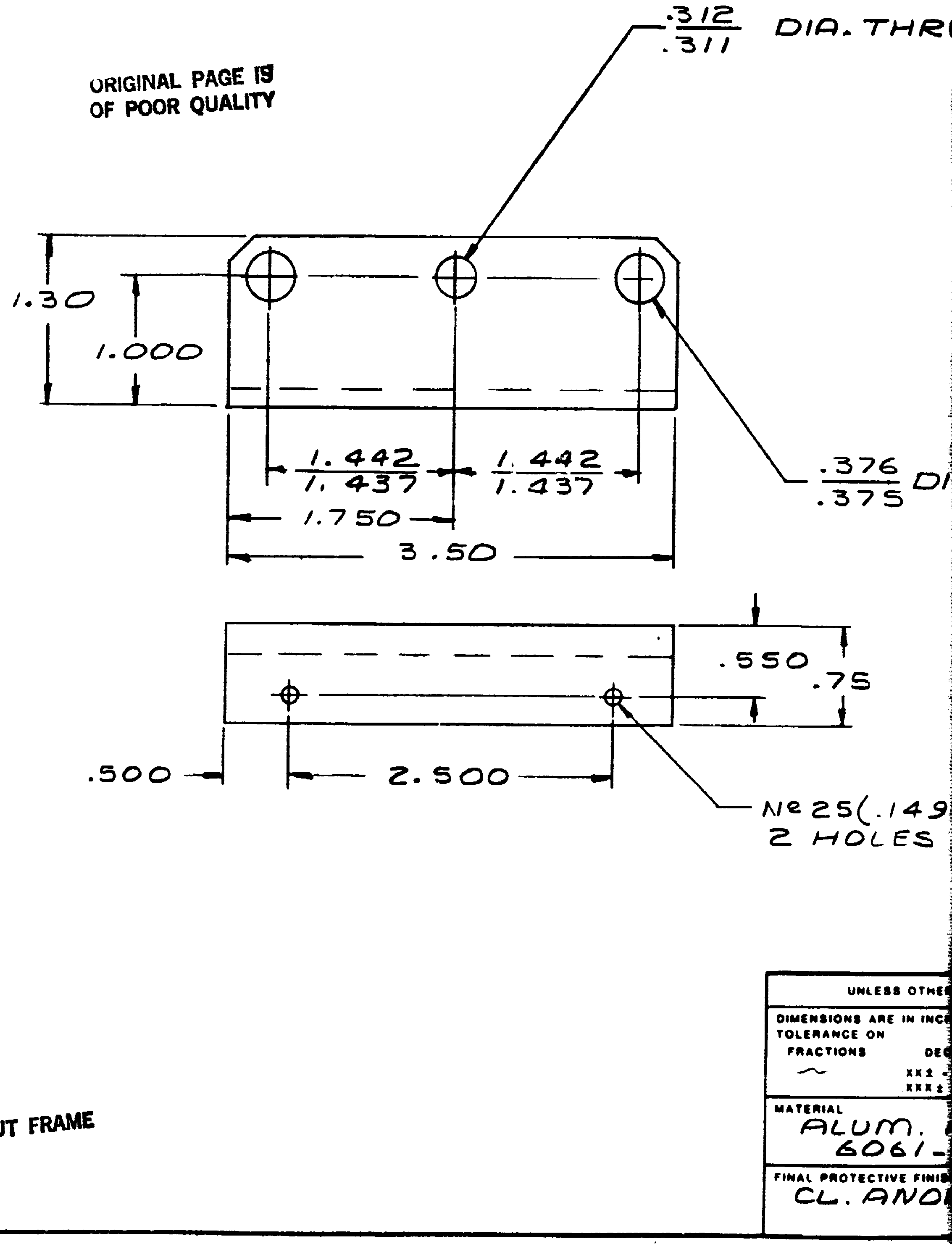
$\frac{6}{5}$ DIA. THRU 2 PL.

FOLDOUT FRAME

NOTE ~
1- REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02 R.

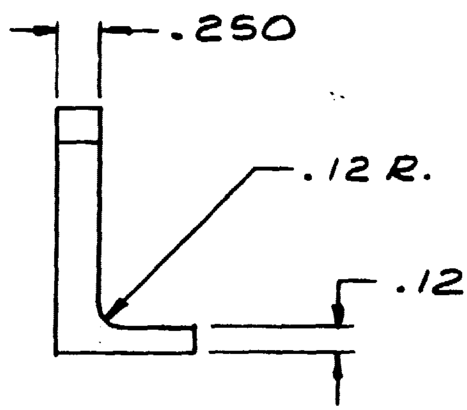
UNLESS OTHERWISE SPECIFIED ENSIONS ARE IN INCHES ERANCE ON ACTIONS / DECIMALS .XX± .015 .XXX± .005 / ANGLES 1°	ESSEX — HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
ERIAL ALUM ALLOY 6061-T6	MOTOR MOUNT	DATE 4-18-84
L PROTECTIVE FINISH LEAR ANODIZE / SCALE 1-1		APPROVED
		CONTRACT 00478
		DRAWING NUMBER 478018
		SHEET OF

ORIGINAL PAGE IS
OF POOR QUALITY



FOLDOUT FRAME

IA. THRU



$\frac{.376}{.375}$ DIA. THRU 2 PL.

NOTE ~
1- REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02R.

.75

25(.149 DIA.) DRILL THRU
HOLES

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED
NSIONS ARE IN INCHES
RANCE ON
ACTIONS ~ DECIMALS XX± .015 XXX± .005 ANGLES 1°

RIAL
ALUM. ALLOY
6061-T6

PROTECTIVE FINISH
L. ANODIZE

SCALE
1-1

ESSEX
HUNTSVILLE FACILITY
3322 S. MEMORIAL PARKWAY
HUNTSVILLE, AL. 35801

BRACKET

DRAWN BY
LOUGHEAD

DATE
4-18-84

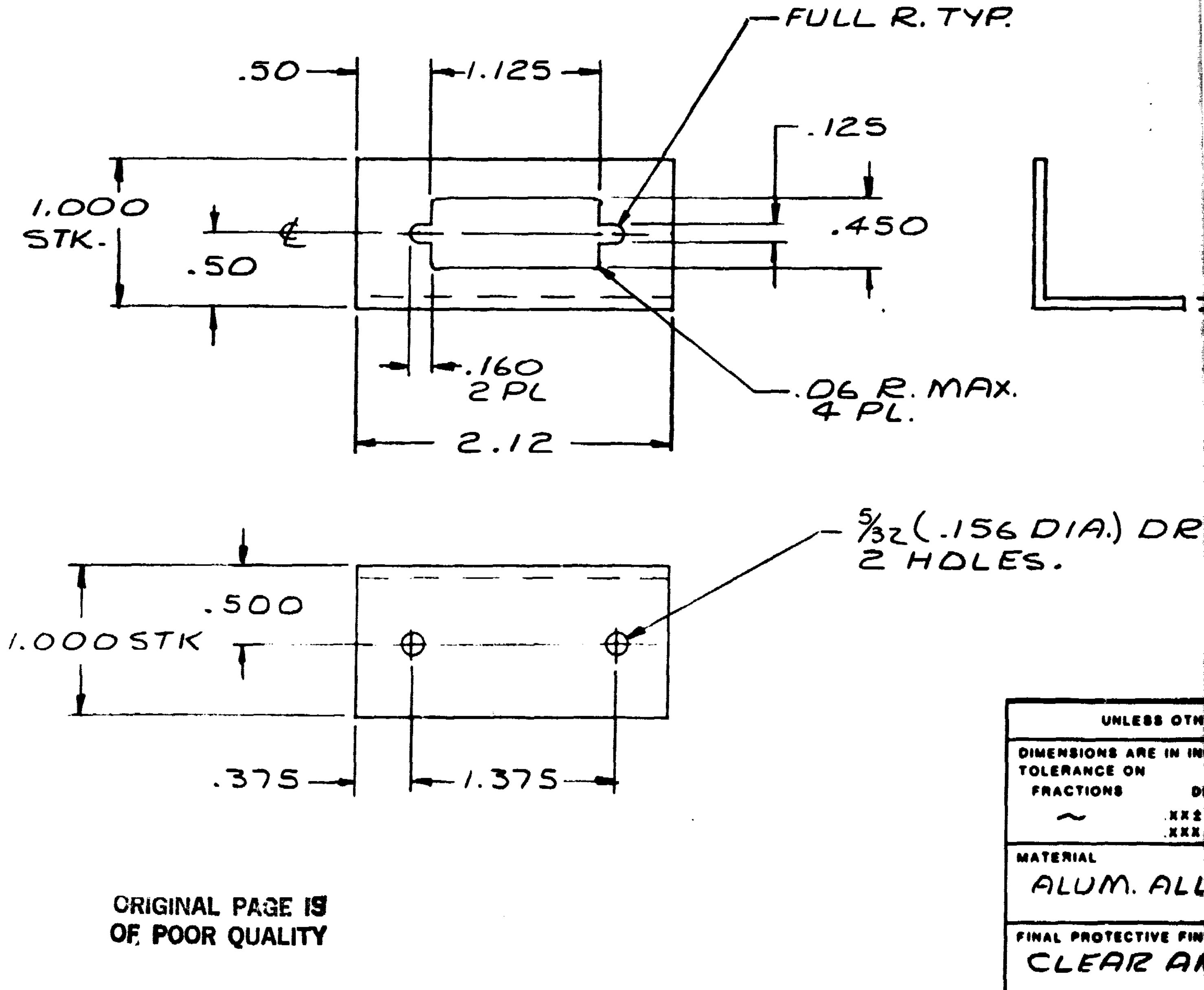
APPROVED

CONTRACT
00478

DRAWING NUMBER
478019

SHEET OF

FOLDOUT FRAME



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ORIGINAL PAGE IS
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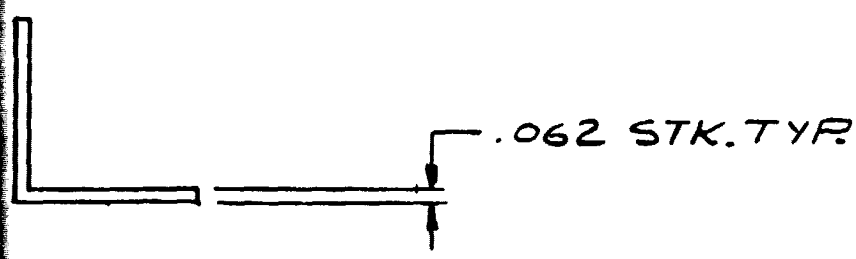
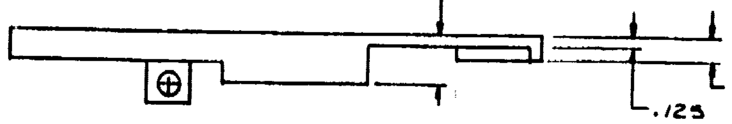
2 FOLDOUT FRAME

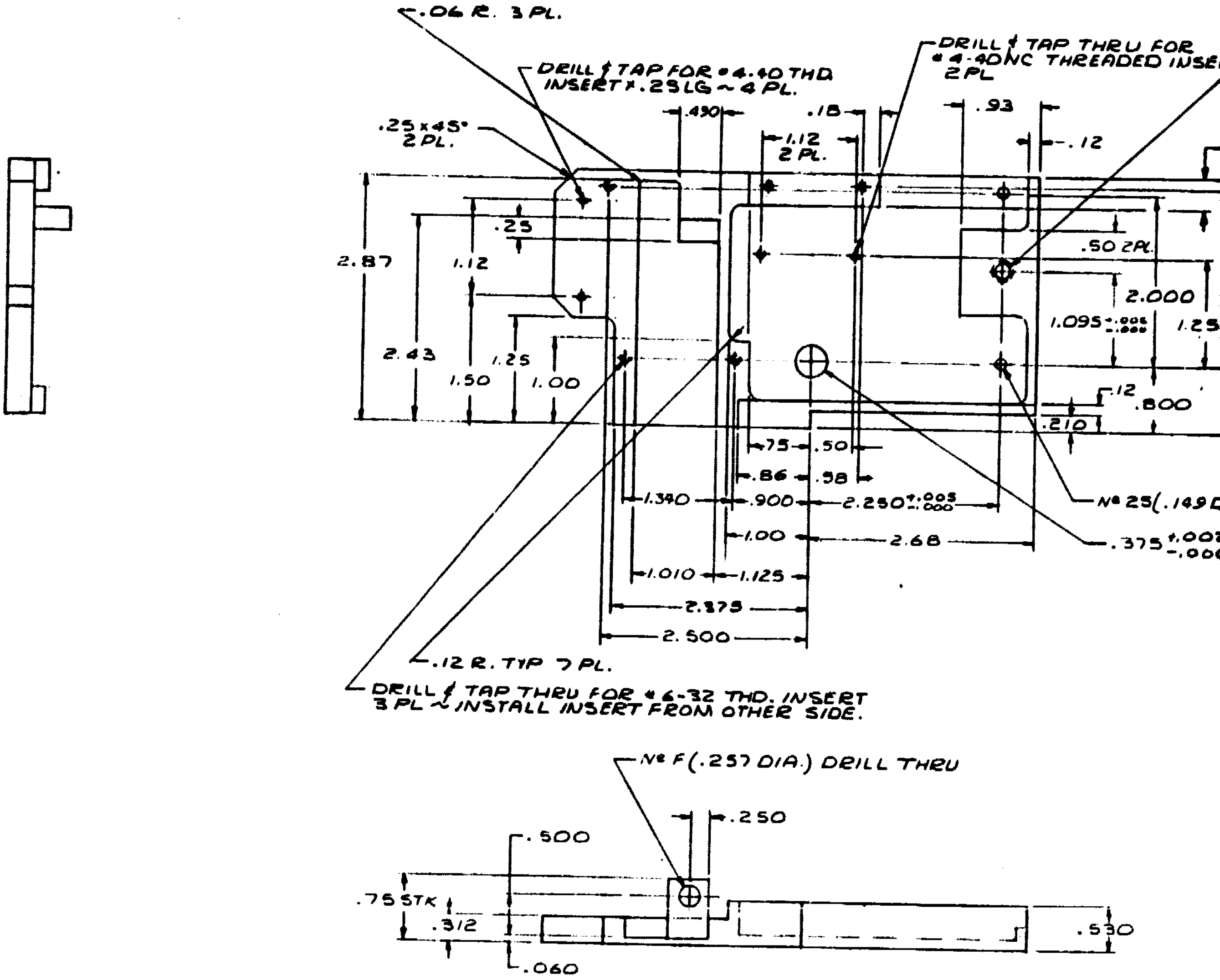


NOTE ~
1 - REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02 R.

DIA.) DRILL THRU
S.

UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
MENSIONS ARE IN INCHES OLERANCE ON FRACTIONS ~ DECIMALS .XX ± .015 .XXX ± .005 ANGLES ~	BRACKET ~ CONNECTOR	DATE 4-18-84
TERIAL ALUM. ALLOY 6061-T6		APPROVED
AL PROTECTIVE FINISH CLEAR ANODIZE — SCALE 1-1		CONTRACT 00478
		DRAWING NUMBER 478020
		SHEET OF





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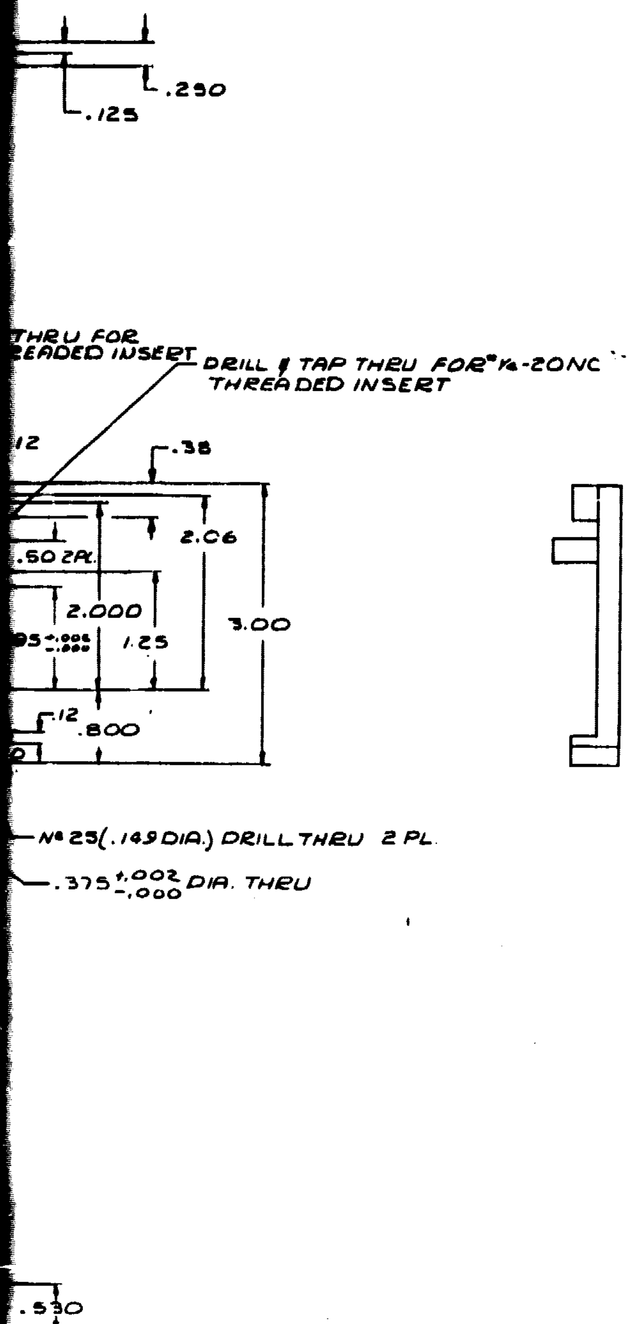


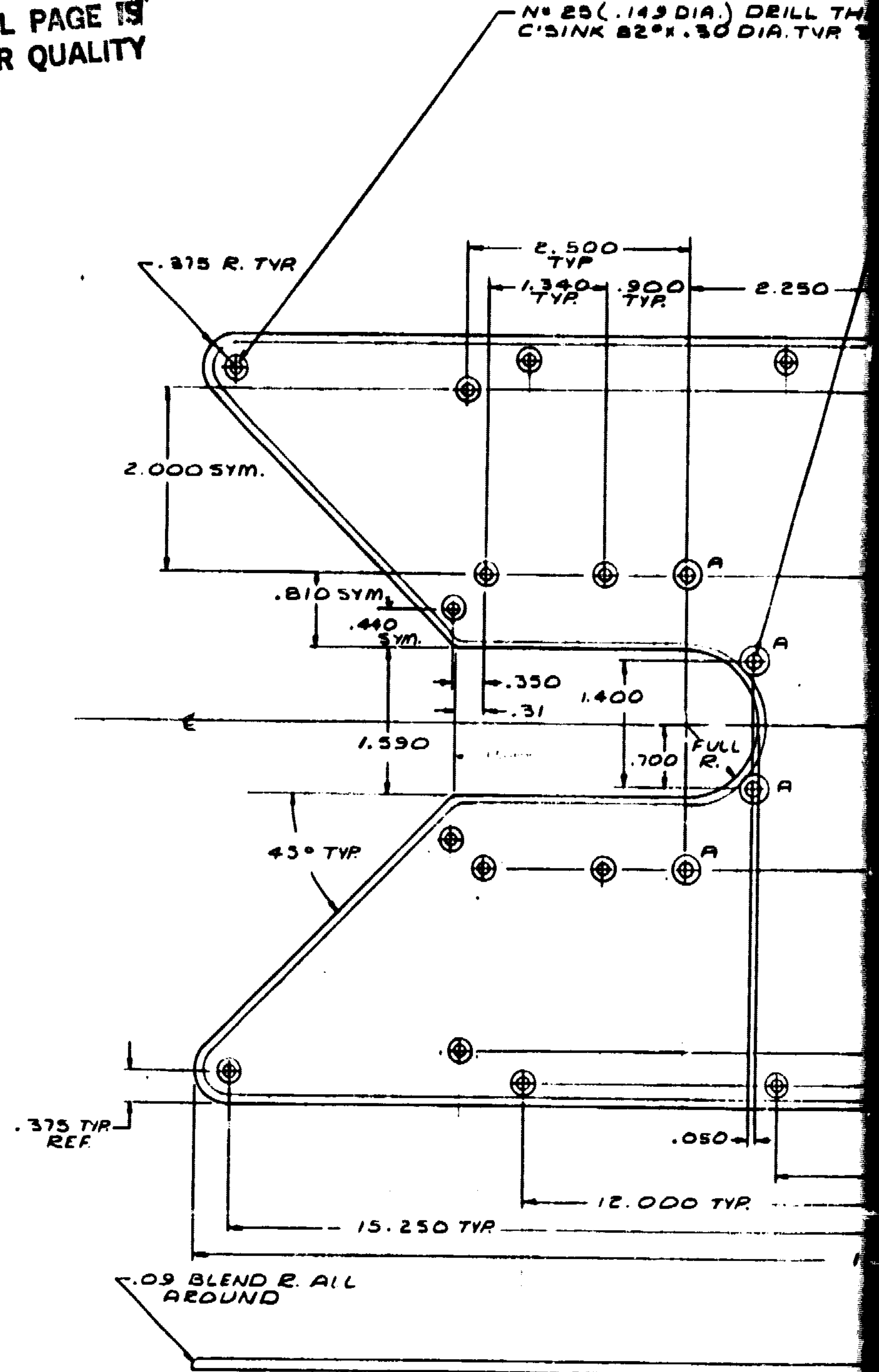
NOTE ~

1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R.

2~ RH 478021-1 SHOWN
L.H 478021-2 OPPOSITE

FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS / DECIMALS .XX .015 .XXX .005 / ANGLES 1°	ESSEX	HUNTSVILLE FACILITY	DRAWN BY: SHEAD
MATERIAL: AL ALLOY 6061-T6	LATCH MOUNT		DATE: 4-30-84
FINAL PROTECTIVE FINISH: HARD ANODIZE .8 TO 1.5 MIL THK	SCALE: 1-1		CONTRACT: 00478
			DRAWING NUMBER: 478021



FOLDOUT FRAME

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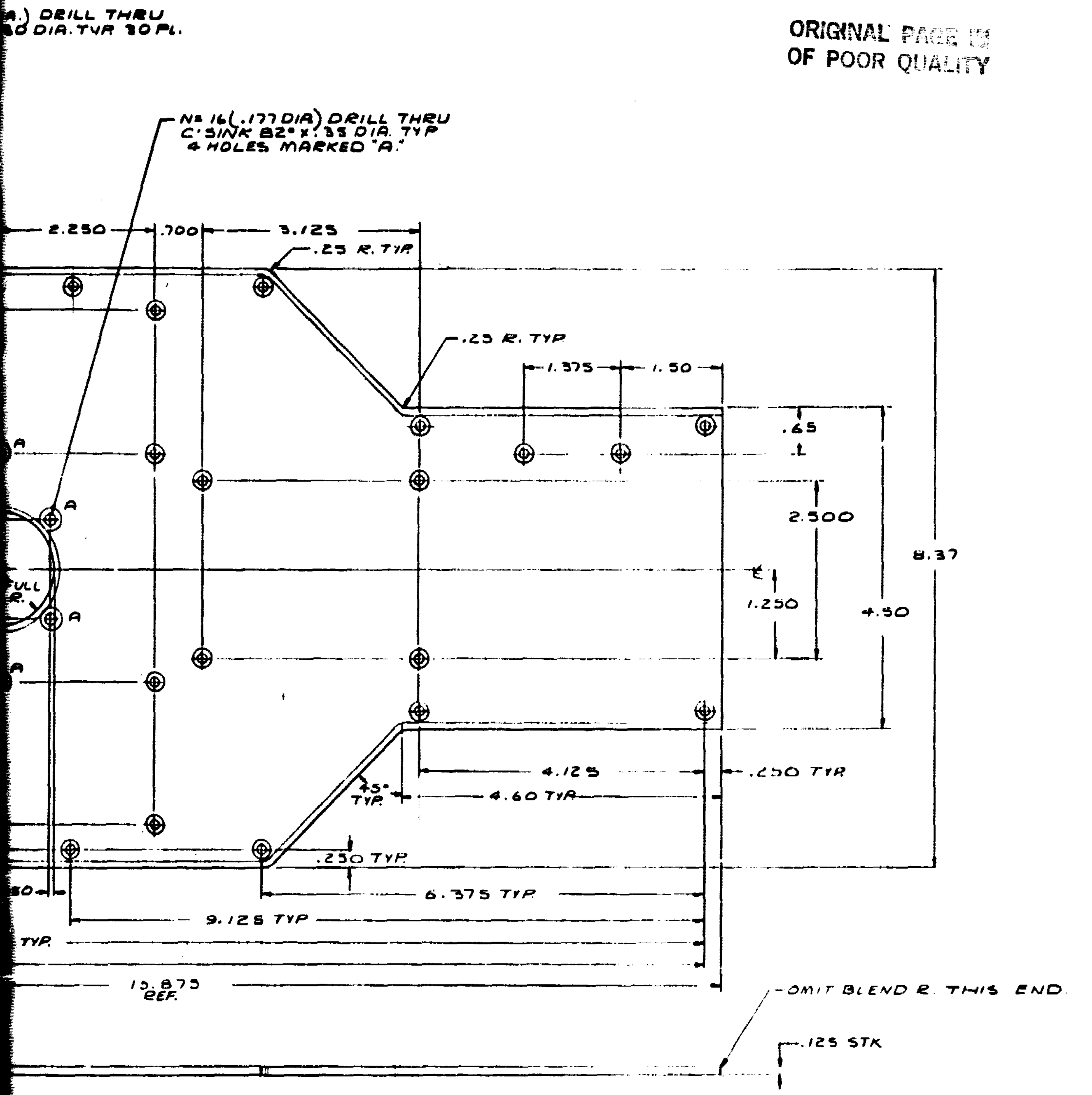

NOTE~
1. REMOVE ALL BURRS & BREAK ALL SHARP EDGES
2. HARD ANODIZE ALL OVER~ PAINT WHITE ON SURFACE SHOWN

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED	ESSEX	BASE PLATE	DRAWN BY: Toushfad
DIMENSIONS ARE IN INCHES, TOLERANCE ON: DECIMALS .XX ± .015, .XXX ± .005; ANGLES ±0°			DATE: 5-1-86
MATERIAL: ALUM ALLOY 6061-T6			CONTRACT: 00978
FINAL PROTECTIVE FINISH: 2	SCALE: 1-1		DRAWING NUMBER: 478022

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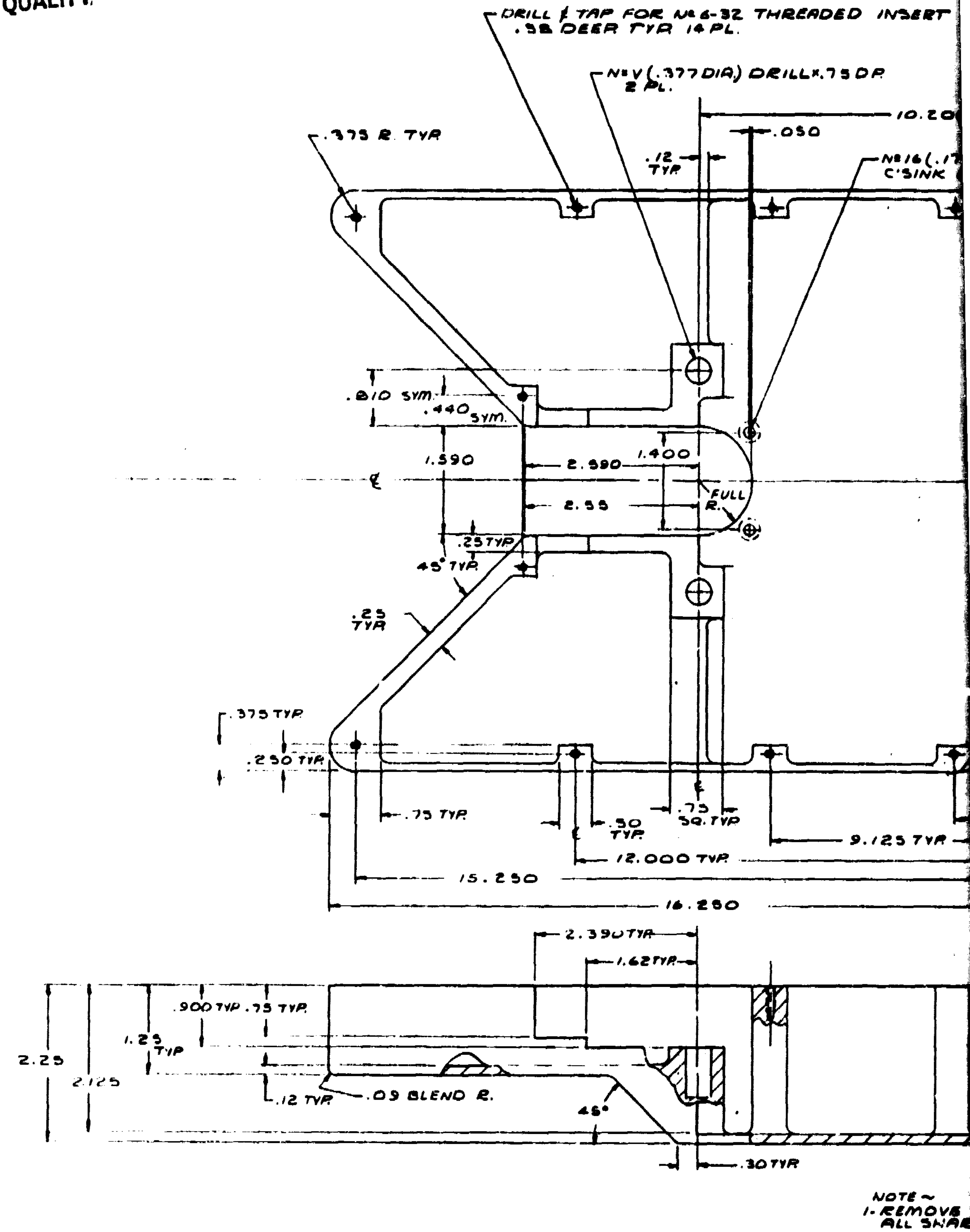
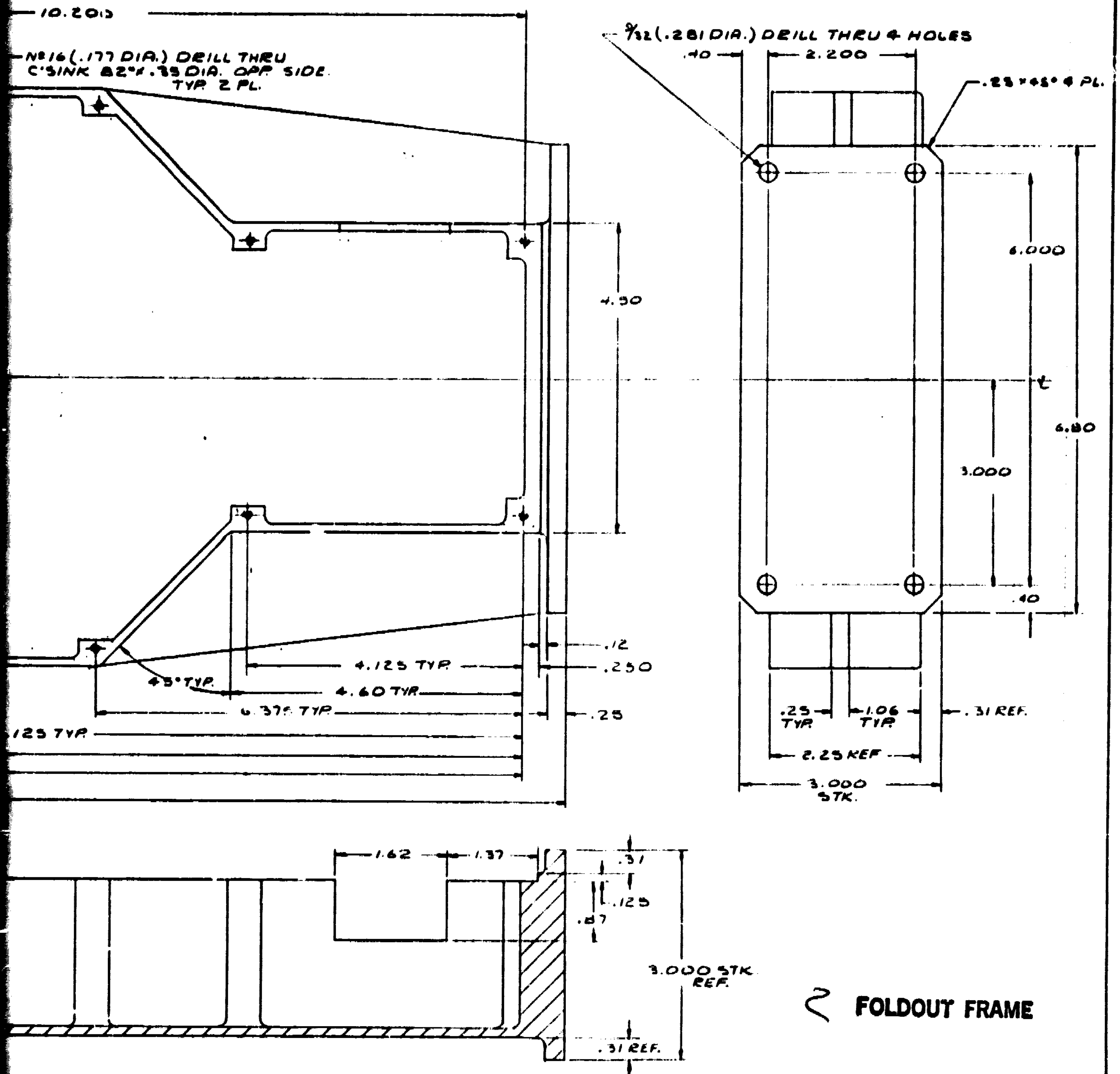


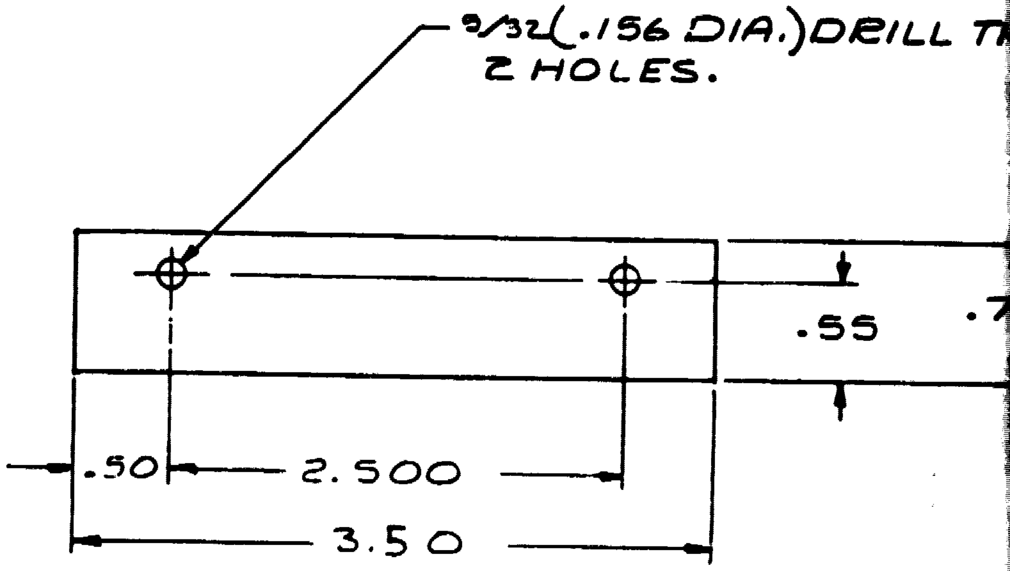
FOLDOUT FRAME



FOLDOUT FRAME

NOTE ~
1. REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02 R
2. UNLESS OTHERWISE SHOWN— ALL FILLETS .12 R
3. HARD ANODIZE ALL OVER— PAINT EXTERIOR SURFACES WHITE.

UNLESS OTHERWISE SPECIFIED — DIMENSIONS ARE IN INCHES, TOLERANCES ON: FRACTIONS ~ DECIMALS .XX ± .015 .XXX ± .005 ANGLES ± 1/2°	ESSEX	DRAWN BY: J. JUHEAD DATE: 3-9-86 CONTRACT: 30278
MATERIAL: ALUM. ALLOY 6061-T6	HOUSING	DRAWING NUMBER: 478023
FINAL PROTECTIVE FINISH: 3 — SCALE: 1-1		SHEET OF



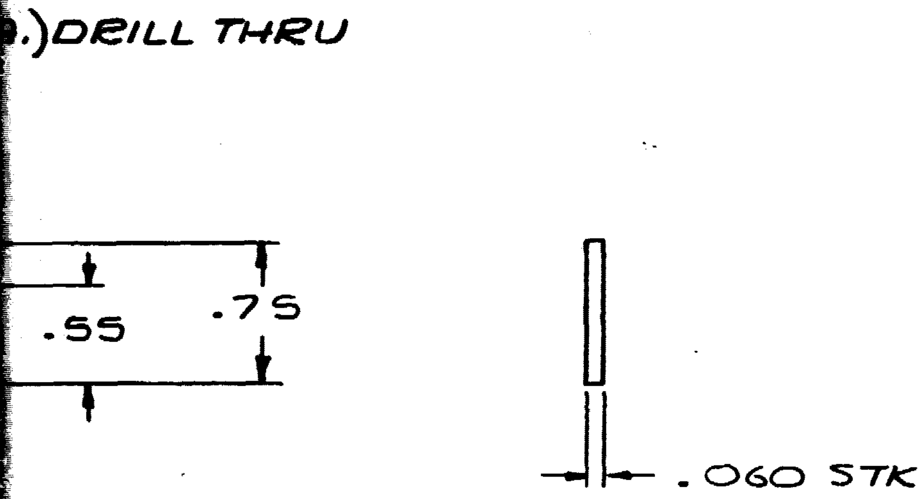
UNLESS OTHER

DIMENSIONS ARE IN INCH
TOLERANCE ON
FRACTIONS
~

MATERIAL
ALUM AL

FINAL PROTECTIVE FINISH
CLEAR AN

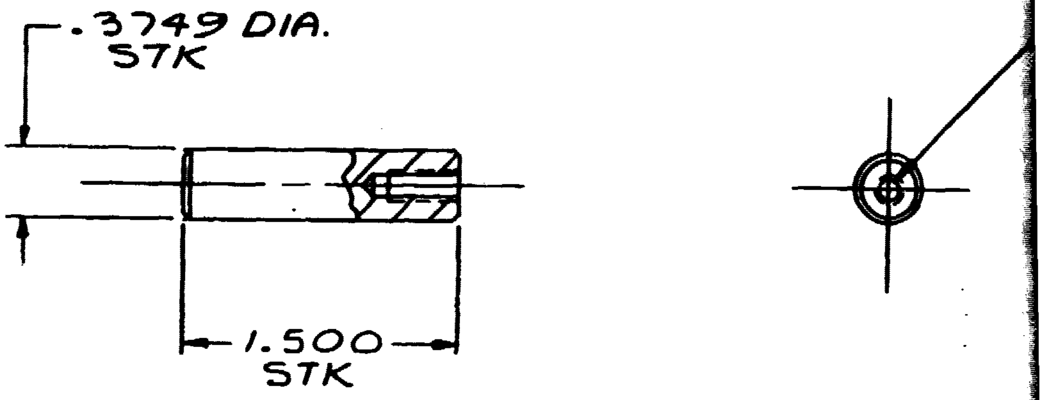
ORIGINAL PAGE IS
OF POOR QUALITY



FOLDOUT FRAME 2

C-2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS ~ DECIMALS .XX ± .015 .XXX ± .005 ANGLES ~	ESSEX HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
MATERIAL ALUM ALLOY 6061-T6	SHIM	DATE 5-11-84
FINAL PROTECTIVE FINISH CLEAR ANODIZE		APPROVED [signature]
SCALE 1-1		CONTRACT 00978
		DRAWING NUMBER 478024
		SHEET OF



UNLESS OTHE
DIMENSIONS ARE IN INC
TOLERANCE ON
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~
DEC
.XX ±
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FINAL PROTECTIVE FINIS
PASSIVA

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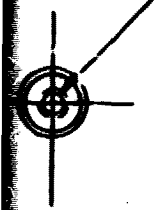
OF POOR QUALITY

#8-32NC TAP x .38 DP.



NOTE~
1- REMOVE ALL BURRS & BREAK ALL SHARP EDGES .01-.02R

2 MAKE FROM BERG P/N D21-16.

FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED [DIME]NSIONS ARE IN INCHES [TOLE]RANCE ON [FRA]CTIONS ~ DECIMALS XX ± .015 XXX ± .005 ANGLES 1° [MATE]RIAL 2 [&] PROTECTIVE FINISH PASSIVATE — SCALE 1-1	ESSEX — HUNTSVILLE FACILITY 3322 S. MEMORIAL PARKWAY HUNTSVILLE, AL. 35801 SHAFT	DRAWN BY LOUGHEAD DATE 5-11-84 APPROVED [signature] CONTRACT 00478 DRAWING NUMBER 478025 SHEET OF

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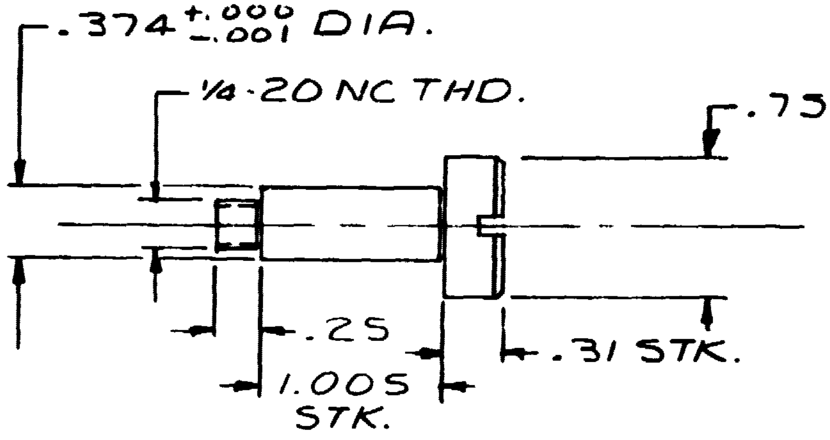

UNLESS OTHE
DIMENSIONS ARE IN INC TOLERANCE ON FRACTIONS ~ DE .XX ± .XXX ±
MATERIAL MAKE FRO PL 45-3
FINAL PROTECTIVE FINI PASSIVAT

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5 DIA. STK.

NOTE ~

1 - REMOVE ALL BURRS & BREAK ALL SHARP EDGES.

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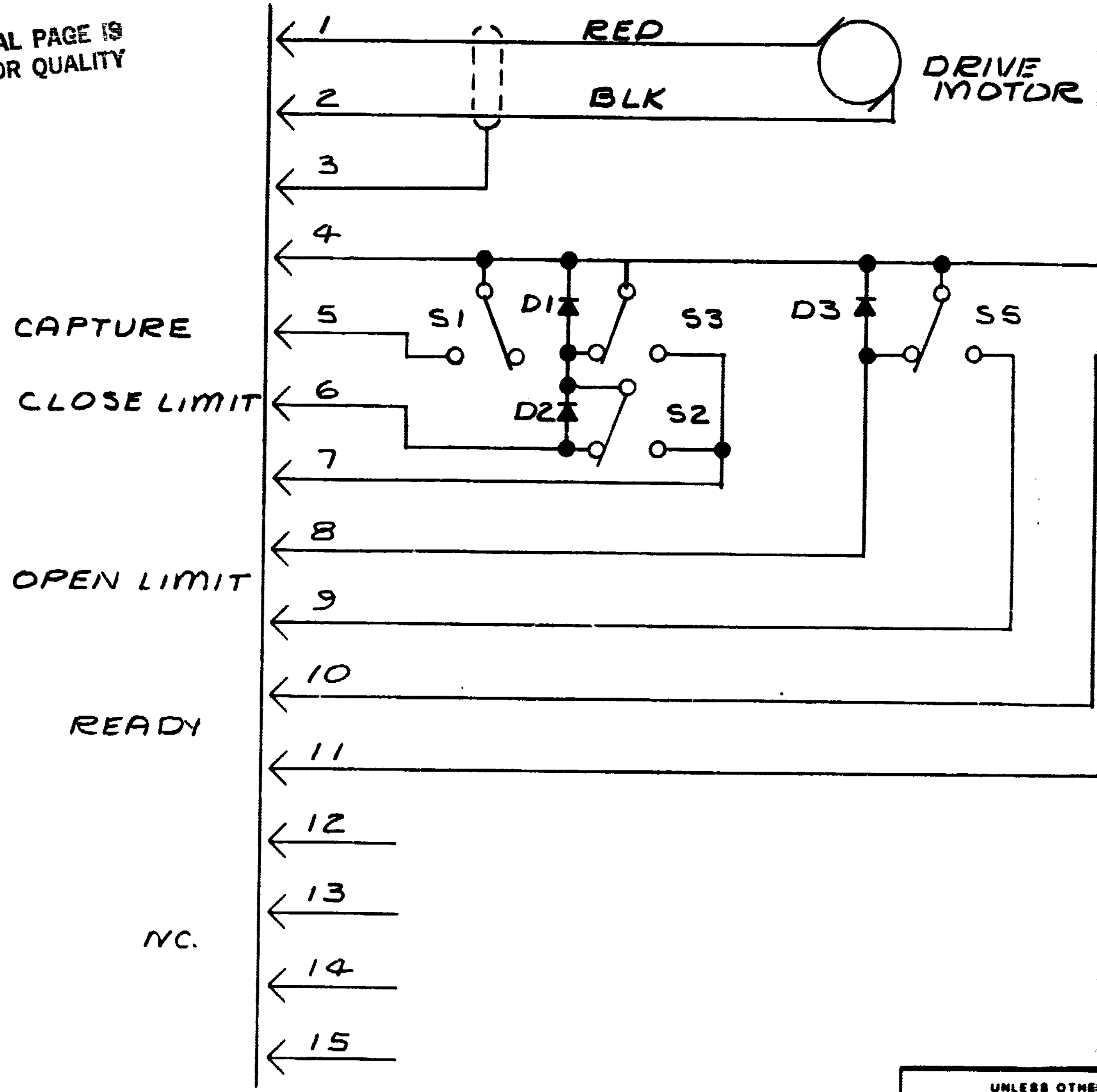
UNLESS OTHERWISE SPECIFIED	ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
DIMENSIONS ARE IN INCHES. TOLERANCE ON FRACTIONS ~ ; DECIMALS .XX ± .015, .XXX ± .005 ; ANGLES ~	SHOULDER SCREW (MOD.)	DATE 5-10-84
		APPROVED [signature]
MATERIAL MAKE FROM BERG No PL 45-3		CONTRACT 00478
FINAL PROTECTIVE FINISH PASSIVATE	SCALE 1-1	DRAWING NUMBER 478026
		SHEET OF



UNLESS OTHE

DIMENSIONS ARE IN INC
TOLERANCE ON
FRACTIONS DE
~ XX ±
XXX ±

MATERIAL
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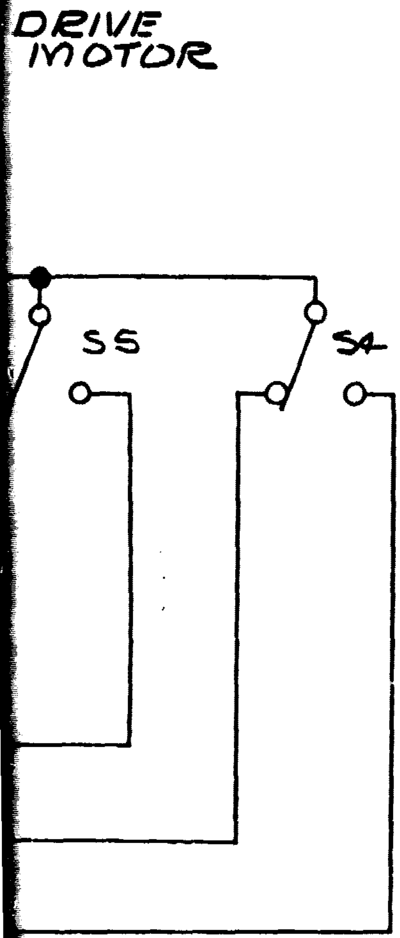

UNLESS OTHERWISE SPECIFIED
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FRACTIONS ~ DECIMALS .XX± .XXX± ~ ANGLES ~
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AL PROTECTIVE FINISH ~
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ESSEX
HUNTSVILLE FACILITY
3322 S. MEMORIAL PARKWAY
HUNTSVILLE, AL. 35801

ELECTRICAL
SCHEMATIC ~
DOCKING LATCH

DRAWN BY: LOUGHEAD
DATE: AUG 20-80
APPROVED
CONTRACT: 00478
DRAWING NUMBER: 478027
SHEET OF

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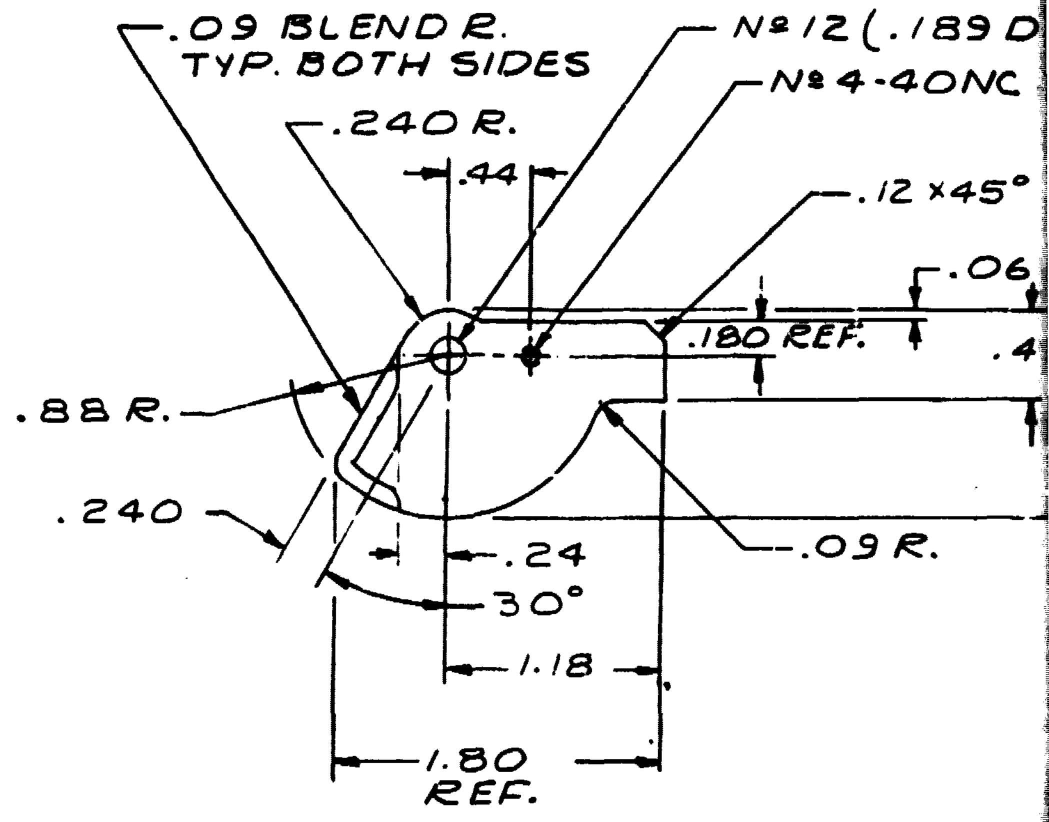

UNLESS OTHER

DIMENSIONS ARE IN INCHE
TOLERANCE ON
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XX± .
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MATERIAL
303 CRES

FINAL PROTECTIVE FINISH
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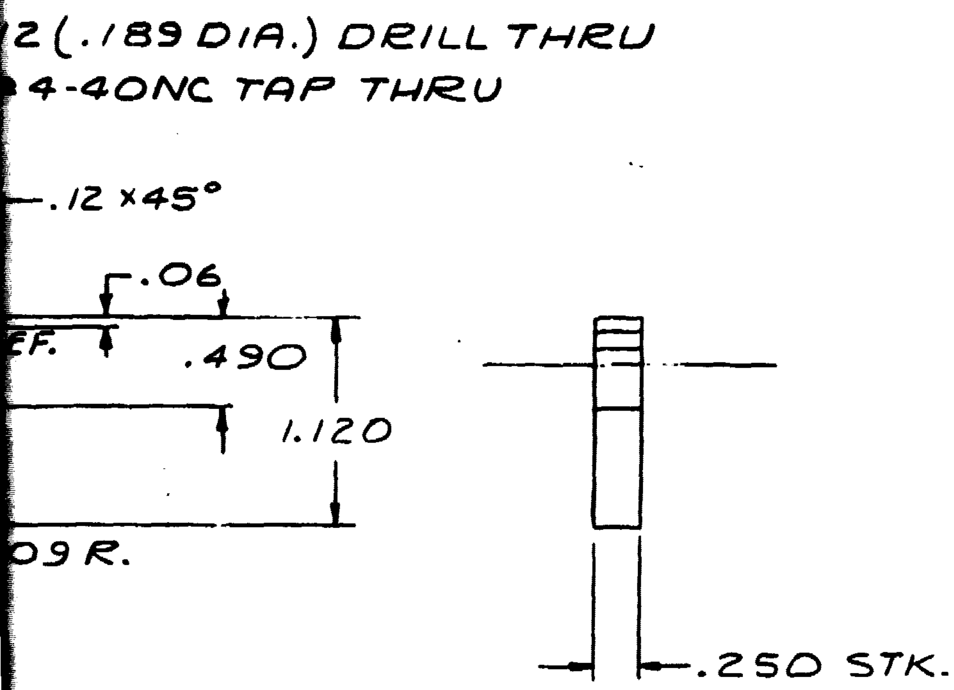

NOTE ~
1- REMOVE ALL BURRS & BREAK
ALL SHARP EDGES .01-.02 R.

2 FOLDOUT FRAME

UNLESS OTHERWISE SPECIFIED		ESSEX — HUNTSVILLE FACILITY, 3322 S. MEMORIAL PARKWAY, HUNTSVILLE, AL. 35801	DRAWN BY LOUGHEAD
NSIONS ARE IN INCHES RANCE ON CTIONS ~ DECIMALS XX± .015 XXX± .005	ANGLES ½°		DATE MAY 4 -84
		PAWL	APPROVED
RIAL 03 CRES			CONTRACT 00478
PROTECTIVE FINISH ASSIVATE	SCALE 1-1		DRAWING NUMBER 478030
			SHEET OF